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BRITISH ORIBATIDÆ.

BY

ALBERT D. MICHAEL,

F.L.S., F.R.M.S., &c.

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PREFACE.

The reader will kindly remember that this book is the record of work done in the scanty leisure of a very busy man; it does not profess to be a monograph. A monograph should contain drawings and descriptions of all species of the group treated of which are found within the district included in the work; it should describe each species in all its stages, and it should give full particulars of the anatomy, development, habits, classification, &c. This book only describes and figures such species as I am acquainted with living in the district, and gives such information respecting them as I am possessed of—a very different matter from the ideal monograph; for I am not sanguine enough to imagine that my almost unaided labours, confined to such times as could be spared from the practice of my profession, and from other pursuits, during the last few years, have been sufficient to discover all, or nearly all, of the British species; or that my knowledge of their organisation, and of the various biological facts connected with them, is anything but a very small contribution towards what it is possible for the human mind to attain to, or even towards what will probably be known some day. Although a perfect monograph

possibly never has been and never will be written, yet, on many subjects, successive investigators have gradually accumulated a mass of information which entitles a book sweeping it all in to be called a monograph: this is not the case in any branch of the *Acarina;* especially in that of the *Oribatidæ*, for the known researches are exceedingly few. Some five years ago, when I first turned my attention to the subject, there was hardly a single record of the capture of any species in the British Isles, and very little was known concerning them. Two or three Continental works, which will be found noticed in the chapter on bibliography, gave a partial insight into the fauna of this family in France and Germany, but these works are no freer from errors than the early treatises on other groups. The immature stages were only professed to be known in twelve instances, and some of these were wrong. Nicolet's was the only work dealing with the anatomy in any way; and, excellent as his book is, the mistakes in this portion of it are neither few nor slight. Thus I was thrown chiefly upon "my own resources," and it is not by one man's original investigations or collections made during five years that a monograph is formed.

It must not be supposed from the above remarks that this book has been slightly or carelessly put together. As regards the British *Oribatidæ* I have been strictly a pioneer, but I do not think that I have spared pains to make the work as complete as the circumstances permitted, and I believe that it is sufficiently so to be of substantial service to future workers on the same subject.

My collecting has extended over the period above named, and has been conducted at Epping Forest,

in Essex; Dorking, Wandsworth, and Mortlake, in Surrey; at Hoddesden, in Hertfordshire; at Hopwas Wood, near Tamworth, in Warwickshire; at Swanage, in Dorsetshire; at Lynton and Chagford, in Devon; at the Land's End, Cornwall; at Swaledale, Teesdale, and Eskdale, in Yorkshire; and on the shores of Loch Maree and Loch Ewe, in the Ross-shire Highlands. In addition to this, Mr. C. F. George, of Kirton Lindsey, in Lincolnshire, has searched that neighbourhood for me; and I have received ample supplies of material from Stone, in Staffordshire, through the kindness of Mr. E. Bostock, of that place. I have also had contributions from Leeds and from other places. The only one of these spots where I have detected what appears to be a local fauna is the Land's End.

Probably no portion of the work has been more laborious or more interesting than that of tracing the life-histories of the different species so as to ascertain the immature stages; this has, in every instance, been done by actually rearing known specimens in confinement, each specimen being in a glass cage which did not contain any other creature except the one to be watched. Thus I think there is practically a certainty that the results obtained are correct, but the amount of care and attention required is probably greater than any person who has not tried a similar process would believe. The creatures are minute, scarcely visible at all to the naked eye. When in the cage (or cell) every inspection must be made under a microscope of some sort; the creatures hide in the moss or blotting paper, which it is necessary to put into the cell (for they must be fed and kept damp), and yet they must be examined to see what is going on. They must not

ever be touched with a needle or any hard instrument. Many of them take months to have their changes traced; indeed, I have had a single specimen alive in the cage for over a year before its changes were complete, so that I might say with certainty to what species the larva or nymph belonged. During this time the cage must be examined every day, and it must be ascertained that the proper hygrometric condition is maintained. There must not be drops of condensed moisture on the glass, and yet the air in the cell must be kept damp. I have often had fifty such cages in action at one time, each one with its inhabitant; the cages must accompany the observer in every journey, as a few days' neglect would kill all the specimens. For my own part I should have been wholly unable to devote sufficient time to the care of the captives, and it is therefore to my wife's patient attention to them, and to her skilled hand in moving them that I owe my success in rearing them.

Such anatomy as I am enabled to present to the public has not been traced without difficulty; the extremely minute size of the objects, the dark colour, opacity, and excessive hardness and brittleness of the chitinous exo-skeleton, and the softness and delicacy of the internal parts have rendered the task far from easy. In describing the anatomy I have not relied on any previous writer without verification; indeed, I have endeavoured to carry the same system into the other parts of the book, and where I have been unable to do so I have called attention thereto.

The time at my disposal has not enabled me to make any investigations into the embryology of sufficient importance for me to think it desirable to insert them in the present volume. I have considered it

better to omit that subject for the present, hoping to deal with it more fully hereafter.

I have great pleasure in acknowledging the obligations I am under to the Rev. Prof. T. Wiltshire, the Secretary of the Ray Society, for his unfailing courtesy and attention during the progress of the work; to Prof. C. Stewart, of St. Thomas's Hospital, for the assistance of his excellent opinion and advice as to the results obtained in the investigation of the internal anatomy; to Mr. Rhein for his careful engraving of my drawings upon stone, and the pains he has taken to reproduce my effects as far as the means at command permitted; to Mr. E. Bostock, of Stone, for assistance in collecting in his neighbourhood; and to Mr. C. F. George, of Kirton Lindsey, for similar aid at an earlier period; to Mr. C. O. Waterhouse, of the British Museum, for advice on various points; and to M. P. Mégnin, of Versailles, Dr. P. Kramer, of Halle, Dr. G. Haller, of Putbus, Profs. G. and R. Canestrini, of Padua, Prof. A. Berlese, of Padua, Prof. A. Croneberg, of Moscow, Prof. A. L. Donnadieu, of Lyons, Prof. T. Thörell, of Upsala (and Genoa), Herr Konnike, of Bremen, Dr. H. Henking, of Göttingen, Dr. C. Nörner, of Vienna, M. F. A. Förel, of Lausanne, and others for reprints of their papers and information as to their researches affecting the *Acarina*; also to Mr. P. Cameron, of Glasgow, and Herr Poppe, of Bremen, for the opportunity of examining collections of *Oribatidæ* formed in those places respectively; and last, but not least, to Prof. T. Rupert Jones, for his able assistance in revising the literary part of the work.

I propose to deposit in the British Museum a type series of microscopical slides of the species described by me in this work, and, if possible, duplicates with

the Royal Microscopical Society and the Quekett Microscopical Club, which societies have special facilities for the preservation of microscopical objects.

Finally, I may say that if I succeed in introducing a comparatively new subject to my countrymen, and if the study gives to others half the pleasure that it has given to me, I shall be well rewarded for my labours.

ALBERT D. MICHAEL.

CADOGAN MANSIONS,
SLOANE SQUARE, LONDON;
6th March, 1884.

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BRITISH ORIBATIDÆ.

CHAPTER I.

INTRODUCTORY, AND AS TO DISTRIBUTION.

THE family of *Acarina*, which is the subject of the present work, forms a perfectly distinct group, no member of which is likely to be mistaken, by a person accustomed to examine them, for a species of any other family; notwithstanding this it is far from easy to place succinctly before the reader a few leading characteristics by which he can at once recognise them. I shall, in the chapter on classification of *Acarina*, endeavour to meet this want to the best of my ability; for the present it may be sufficient to say that they are a family presenting the following characters. The integument of the adults is almost always hard and chitinous. On each side of the dorsum of the cephalothorax is placed a conspicuous organ, hitherto considered, I think erroneously, to be a stigma. These organs are usually raised, chitinous rings or tubes; I call them the pseudo-stigmata. From inside each springs a structure which Nicolet calls a protecting hair, but which I believe to be a sense-organ, and speak of, in this work, as the pseudo-stigmatic organ. This part, be it hair or organ, is of infinitely varying form, being

scarcely alike in any two species; but it is invariably present, and, with its pseudo-stigma, affords the simplest way of distinguishing the *Oribatidæ* from other families, and the species from each other. The leg has always five moveable joints,* and ends in a monodactyle or tridactyle claw, without sucker or caruncle. The opening of the sexual organs is in the abdomen. The respiration is ordinarily tracheal in the mature creatures. The mandibles are almost always chelate.

The adult forms probably have not the beauty of many other families of *Acarina* and Insects; but, on the other hand, some of the immature stages are amongst the most beautiful creatures of the order; and only those who are not acquainted with the *Acarina* can suppose that none are beautiful. It is needless to say that the *Oribatidæ* are highly interesting and instructive, because the same thing may be said of every family of created beings; no one can devote himself to the study of any class of organism without becoming from day to day more deeply impressed with the admirable manner in which its members are adapted to their wants, and the marvellous way in which the different parts are varied in different species, so as to provide more efficiently for their protection and continuance. This fact of having constantly before his eyes the wonders of the individual family or order which he is investigating, is apt to cause the specialist to forget for the time that there are hundreds of other families equally interesting, beautiful, and wonderful in their construction and life-histories. It is only by endeavouring to base his special knowledge upon the wider foundation of general interest in the works of nature that the naturalist escapes this error, and appreciates the harmony between the particular class and other equally glorious types of life. Endeavouring to bear all this in mind, I feel that I am not

* There may be one or two instances in which one joint is divided into two.

justified in saying that the *Oribatidæ* have any claim on the biologist beyond that of any of the endless varieties of other forms of animals; but I do say that they have an equal claim; and I think I may confidently assert that any observer who inquires into the complex structure of these minute creatures, their singular life-histories, or the quaint and somewhat exceptional habits of some of the species, will rise from his task fully rewarded for the time that he has spent.

The *Oribatidæ* are entirely of microscopic size, and without a microscope the keenest-eyed naturalist would do but little, as the largest known species are scarcely over the twentieth of an inch in length, while the smallest are under a fifth of that measurement. It will easily be understood that this very small size renders it far from easy to ascertain their structure, or to study their life-histories, particularly when we remember the difficulty of their possessing, in the adult stages, a chitinous exo-skeleton of extraordinary brittleness, and often so black and rough that a very high concentration of light is necessary to see them properly; while the necessity for using moderately high amplifying powers renders strong reflected light more difficult to obtain; and, moreover, strong light is most unwelcome to the creatures, almost all of which live in comparative darkness, and avoid the light as much as possible.

The whole family are, as far as I know, strictly vegetable feeders, although I have sometimes felt doubtful about *Pelops*, and it is not known that any of the species are injurious to man or his works. It is true that Nicolet says that if deprived of vegetable food and pressed by hunger they will attack and devour other softer bodied *Acarina*. Although I have not myself seen any instance of this amongst the large numbers of *Oribatidæ* which I have, from time to time, kept in a living state for observation, it may none the less be true; possibly my captives have been too well fed to be under

the necessity of departing from their natural instincts. If true I do not see that it proves much; the natural food is vegetable, the trophi are entirely adapted to a vegetable diet, the contents of the intestines in a state of nature are vegetable, and a few exceptional instances, under forced artificial circumstances, do not appear to me to be important.

The family of *Acarina* treated of in this work is probably the only large one no species of which is ever parasitic at any period of its existence, either temporarily or otherwise. The *Trombidiidæ* are strictly predatory in the adult stage, but have larvæ which, although not originally parasitic any more than a gnat or a leech, will yet attach themselves to the bodies of animals, or even man himself, and are usually separated only by death or artificial means, causing violent irritation while present, and passing by the name of harvest-bug in England and *Rouget* in France, and being the *Leptus autumnalis* of earlier acarologists.

The small predatory family of the *Cheyleti* contains species such as *Cheyletus parasitivorax*, *C. heteropalpus*, &c., which, as M. Mégnin has shown,* are strictly parasitic, although with a form of parasitism not contemplated in Van Beneden's famous classification, viz. a parasitism beneficial to the host, as the guest lives upon other parasites which are injurious to the host.

Among the *Hydrachnidæ* numerous members of the genus *Atax*, &c., are parasitic in the gills and other parts of the fresh-water mussel (*Unio*), &c. Their life-histories while parasitic have been well worked out by Van Beneden† in the case of *Atax ypsilophora*, and by Claparède in that of *Atax Bonzi*.‡ The larvæ of the genus *Hydrochoreutes* attach themselves to aquatic insects; I have found numbers adhering to the eyes of

* Robin's 'Journal de l'anatomie et de la physiologie,' 1878.

† 'Recherches sur l'hist. nat. et le dévelop. de l'Atax ypsilophora,' Brussels, 1850.

‡ "Studien an Acariden," 'Zeit. für wiss. Zool.,' 1868.

the larvæ of *Libellulidæ*, and many of the genus *Hydrachna* are attached to aquatic insects such as *Ranatra*, *Nepa*, &c., during what may well be called the pupa stage, which fact was observed and described by Dugès.*

The *Ixodidæ*, although, like the larvæ of *Trombidiidæ*, not originally parasitic, yet attach themselves in a quasi-permanent manner to animals, and draw nutriment from their hosts.

The *Gamasidæ* are most commonly parasitic during the nymphal stage, and the adult females are also frequently parasitic; the extent of this parasitism is still a matter of extreme doubt. Mégnin† is of opinion that they do not draw any nutriment from their host, but simply use it as a means of conveyance. I have elsewhere given my reasons for being somewhat dubious about this,‡ *but there is not any doubt about the parasitism.*

The *Tyroglyphidæ* are usually parasitic during the curious hypopial stage, although they do not seem to require any nutriment from the host; and some species of the same family would appear to be parasitic in the adult stage, as *Glyciphagus balænarum*. The *Sarcoptidæ* and *Myobiidæ* are wholly and strictly parasitic during every stage of their existence.

In marked contra-distinction to all these other groups of *Acarina*, all known *Oribatidæ* at every stage of their existence are free organisms, not in any way parasitic, and not looking to any host either for nutriment or conveyance.

All members of the family are slow creatures, many of them sometimes remain motionless for hours, and it is by no means easy to distinguish some of the immature ones from the vegetable substances upon

* "Deuxième mémoire sur l'ordre des acariens," 'Ann. sci. nat.,' 1834, 144.

† "Mémoire sur l'organization et la distribution zoologique des acariens de la famile des gamasides" 'Robin's Journal de l'anat. et de la physiol.,' May, 1876, p. 288.

‡ 'Journal of the Linnean Soc.,' 1881, "Zool.," vol. xv, p. 297.

which they are found. Other species are not so inert, but rapid motion is not found in any. The mature forms are probably a trifle more active than the immature, but both are sluggish. Nicolet has taken the trouble to calculate the rate of progress of several species, from different genera, when actually walking, and as it may be interesting to some of my readers I give the results, which he has tabulated as follows:

Names of Species.	Distance (in millimètres) traversed per minute on the average.
Pelops acromios	18·75
Oribata alata	16·80
,, *Edwardsii* . . .	28·50
,, *nitens*	10·50
Leiosoma nitens . . .	8·45
,, *simile*	14·
Notaspis bipilis	50·
Cepheus latus	18·
Eremæus tibialis . . .	21·18
Tegeocranus cepheiformis (*latus*)	7·44
Damæus auritus (*clavipes*) . .	56·66
Nothrus horridus . . .	·90
Hoplophora major (*magna*) .	10·
,, *nitens* . . .	5·
Hermannia crassipes (*picea*) .	12·50

I cannot help thinking that all Nicolet's specimens were not under equally favorable circumstances for making progress, but still doubtless he is fairly correct. I think his *Damæus* must have had some unusual cause of excitement. I have always found it a very slow genus in spite of its long legs.

It may possibly be remarked that the creatures should not be called slow; for in proportion to their size they are swifter than a man. The answer to this is, firstly, that speed in animals does not usually diminish in proportion to size, and, secondly,

that man is a very slow mover. Estimating the movements of the *Oribatidæ* by those of most other *Acari* the difference is very apparent; a *Trombidium* or a Gamasid will often traverse over 100 mm. in a minute.

The *Oribatidæ*, being without any weapons of offence, are more in need of defensive arrangements, and with these they are very fully provided. Many of them are detailed in the chapter on habits, but the varying modes of protecting the legs may be referred to here. The legs are the most vulnerable parts, because they could be readily seized by any small predatory creature, such as a Chelifer, &c., which would otherwise find the *Oribatidæ* difficult morsels to lay hold of when they "sham dead," as they generally do, and rely on the hardness of their chitinous coat. We accordingly find special and curious provisions to guard the legs. The most perfect arrangement is found in the exceptional genus *Hoplophora*, where the cephalothorax is not anchylosed to the abdomen, but is moveably articulated to it, and revolves upon pivots at the posterior sternal angles. The portion of the cephalothorax which projects beyond the abdomen is really little more than the rostrum, and is covered dorsally by the chitinous hood which usually protects the rostrum in *Oribatidæ* forming the camerostomum, this is open below to give passage to the trophi, and when the cephalothorax is bent down, and the creature closed up, the open part of the hood is pressed against the ventral surface, the true dorsal surface of the cephalothorax being next the ground; this will be best understood by reference to the plates illustrating the genus. The hood when thus closed shuts over the legs, but it would not be large enough to cover them were it not for another and still more singular contrivance, which is that the ventral plate, instead of being fixed to the dorsal by its edges all round, is moveable, and capable of considerable elevation at its anterior end, where it is indented to allow the legs to pass. When the legs

are extended the ventral plate rises toward the dorsal, when there is an alarm the plate falls, leaving of course more space within, and into this space the legs can be wholly retracted; the hood of the rostrum falls over the opening where the legs have passed, and the whole creature is as much a hard ball as a closed armadillo.

Next to *Hoplophora*, the most perfect arrangement will be found in the sub-family *Pterogasterinæ*. The arrangement is best seen in some of the genus *Oribata*, such as *O. alata, punctata, globula, lapidaria*, &c.; here the chitinous plate covering the notogaster does not terminate all round where it joins the edge of the sternal plate, but the antero-lateral portion of it is prolonged laterally, so as to form wing-like expansions which curve downwards outside the legs, somewhat in the position of the pleuræ in *Astacus*, *Homarus*, &c., but are not articulated like the pleuræ, being unbroken continuations of the dorsal shield. These wing-like expansions are more or less flexible, and can be slightly extended or brought quite close to the body, at the will of the creature. The legs are so constructed that they work freely in the narrow space between the wing-like expansions and the body, and, when flexed, they can be entirely, or almost entirely, covered up by the expansions. This would be thought sufficient protection, but several of the species of these genera, as, for instance, *Oribata globula*, *O. lapidaria*, *Pelops acromios*, &c., share with other genera, which have not the aliform expansions to the abdomen, a third mode of protection, which I have called that by tectopedia. These are ridges which are carried to their greatest perfection in the genera *Cepheus*, *Tegeocranus*, and *Notaspis*; as in those genera they provide protection for all the legs, whereas in *Oribata*, &c., the aliform expansions provide for the safety of the hind legs. These ridges are different in different genera and species; in *Cepheus* and *Tegeocranus* they leave narrow, deep depressions between them,

into which the legs exactly fit, the leg being usually flexed, and one ridge lying within the flexure, the exterior ridge serving two legs. In *Oribata* the main ridge lies along the side of the cephalothorax, below the lamellæ, and is usually prolonged forward and forms a sharp point; a second and rounder ridge lies between the first and second legs, thus leaving between a straight trench which Nicolet regards as the basilar cavity, but the whole first leg lies within it.

The ordinary English name for the *Oribatidæ* is beetle-mites, and it is a most unfortunate one, because it gives many people the idea that they are parasitic upon beetles, and that the so-called species *Acarus coleoptratorum* of Linneus is a type of the *Oribatidæ*; this creature, however, belongs to an entirely different family, viz. the *Gamasidæ*. The name of beetle-mite has doubtless been given from the general resemblance in appearance of many, indeed most, of the species, to beetles; this resemblance is, however, probably little more than superficial, as in most essential matters the *Gamasidæ* are more closely allied to the true Insects than the *Oribatidæ*; the first pair of legs being true walking legs in the *Oribatidæ* and not used for any other purpose, whereas in the *Gamasidæ* they are usually tactile organs, little, if at all, used for locomotion; and, although pediform, and leg-like in size, they are really more closely allied to palpi, and are placed in close proximity to the mouth-organs. It is not, however, in England only that the expression beetle-mite is used for the *Oribatidæ*, the Germans call them *Käfermilben*, which is, of course, the same thing.

Finally, I may refer to the name of *Oribatidæ* which comes from *Oribata*, a name proposed in 1804 by Latreille* for a genus which included the whole of the present family. The name is euphonious, but not specially applicable; it is derived from two Greek

* 'Histoire générale et particulaire des Crustacés et des Insectes,' Paris, 1804. 'Genera Crustaceorum et Insectorum,' Paris, 1806.

words, ὄρος a mountain, and βαίνω I go. I fear that, looking at the rates of progress shown by Nicolet's table, if one of the *Oribatidæ* had to go up a mountain he would take a considerable time to perform the journey. It is possible that Latreille may have based his name not directly upon ὄρος and βαίνω, but upon the proper name "Oribasus," Acteon's dog, derived from those two words. This genus of Latreille's has practically entirely superseded the name of *Notaspis*, proposed by Hermann, published in the same year,* which is also derived from two Greek words, νῶτος, a back, and ἀσπίς, a shield. This name is unquestionably far the more applicable of the two, but as *Oribatidæ* has been almost universally employed, I have retained it. It will be seen hereafter that Nicolet has revived the name *Notaspis* for a genus while retaining Latreille's name for the family. Great confusion has, however, arisen over the name *Notaspis*, because Hermann unluckily included in it one species which he called *cassideus*, and which is not one of the *Oribatidæ* but belongs to Latreille's genus *Uropoda*, and is consequently one of the *Gamasidæ;* but the genus *Uropoda* is an exceptional genus, bearing a certain general resemblance to the *Oribatidæ*, and Hermann evidently mistook it for a member of that family. Upon this ground in late years Kramer† and Canestrini‡ have treated *Notaspis* as a genus of *Gamasidæ*, notwithstanding that Latreille himself, in his 'Genera Crustaceorum, &c.,' published in 1806, gives *Notaspis* as a synonym of *Oribata*. The identity was recognised by Gervais in 1844,§ where he properly places *cassideus* in Latreille's *Uropoda* thus correcting a mistake as to this species which had been made by both Hermann and

* 'Memoire Aptérologique,' Strasbourg, 1804.

† "Zur Naturgeschichte einige Gatungen aus der Familie der Gamasiden," 'Archiv für Naturges.,' 1876, p. 46.

‡ "Intorno agli acari Italiani," 'Atti del R. Instituto Veneto di sci., let., ed arti,' ser. v, vol. iv (1877).

§ 'Hist. Nat. des Insectes Aptères,' Walckenaer; Paris, 1844.

Latreille. Kramer and Canestrini forgot that all Hermann's other *Notaspes* are *Oribatidæ*, and that Nicolet has used the word *Notaspis* for a genus of *Oribatidæ*. Kramer has corrected this in later works. In this country, Mr. Francis P. Pascoe, in his useful zoological classification, has given *Notaspis* as equivalent to *Oribates* (using Koch's termination of the word, not Latreille's); but, to be absolutely correct, he should have stated it to be equivalent to the family (*Oribatidæ*) not the genus, this being Hermann's original sense, or have shown it as a genus of the family, following Nicolet.

With regard to the distribution of the *Oribatidæ*, we have not sufficient material for forming any exact statement, but we have ample reason for supposing that it is very wide. It might be anticipated that these minute and lethargic creatures would be very local, but on the contrary, this is far from being the case; species which are either identical or extremely closely allied being found not only distributed over the greater part of Europe, but also in the burning plains of Algeria, Chili, and Egypt, and in the far arctic regions of Bell's Sound Spitzbergen, and of Franz-Joseph Land. A large proportion of the species found by Koch near Regensburg have been recorded by Nicolet in France, and in England by myself, and several in Switzerland by Claparède, Haller, and others, and in Italy by Canestrini. *Oribata lapidaria*, first found by Lucas in Algeria, is also an inhabitant of France and England; Thörel has recorded more than one species from Bell's Sound which is also found here; and some short time since Captain Feilden sent me for examination a minute scrap of stone brought from Franz-Joseph Land, in a hole in which his sharp eyes had discovered an acarus; it turned out that it was only the cast skin of a nymph, but even from this slender material I had little difficulty in recognising *Oribata setosa*, a species by no means uncommon in England, and one of those which Thörel had already obtained from Bell's Sound.

Probably the explanation or part of the explanation of the extended area over which these species are found, is that, being very small, very tenacious of life, and inhabiting moss growing on wood, lichen, and the dead wood itself, both adults and ova would be easily carried on floating wood to distant localities.

CHAPTER II.

TERMINOLOGY.

It is a trite remark that an exact terminology is of the greatest value in scientific matters. I imagine that there is not any person bold enough to deny the proposition; it is only when one comes to apply it practically that difficulties arise. It is comparatively easy for a man sitting down to an entirely new subject to devise a terminology which appears to him to be exact; unfortunately other people do not always catch the precise idea which the originator of a technical term intended to convey, and the term consequently appears to them wanting in precision, and, in addition to this, new facts are demonstrated by subsequent observers which show that the original term includes, or does not distinguish between, two or more different things. It is, however, in spite of these difficulties, comparatively easy to give a fairly exact technical expression to the facts and details of an entirely new subject, if such a thing can be found. When, however, as must almost always be the case, others have been before oneself in the field, and also in numerous cognate fields, the matter ceases to be simple. One is confronted by two classes of obstacles, firstly, that different authors have used different terms for the same thing; secondly, that different authors have used the same term in different senses. The first class of difficulty is sufficiently puzzling, because not only is it necessary to learn a fresh system of nomenclature for the works of each writer, which greatly increases the labour of investigation, but also there is always the uncertainty whether the expression used by one author

was, in his mind, exactly coterminous with that used by another, and thus an element of doubt is introduced, which is undesirable. The graver difficulties, however, appear to me to be those of the second class, viz. that the same word has been used by various persons to express things which are not identical. When the respective authors are persons whose ability and care entitle their works to high consideration the later writer finds himself under the necessity of finding some mode of escaping from the dilemma, and four such modes present themselves. Firstly, he may throw overboard all previous systems and devise an entirely new one for himself. Secondly, he may carefully investigate the question as to the sense in which the term was originally used, and adopt that. Thirdly, he may select that sense which seems to him to be the natural and proper sense of the term. Fourthly, he may adopt the sense which seems to him to have been most commonly adopted by writers *on the subject which he is treating of.* The first is far the easiest and pleasantest to the writer, but I fear it is not so to his readers; it serves to encumber them with a fresh system of terminology in addition to those existing, which are too numerous; and in my view every author should, to the best of his ability, endeavour to lessen, not to increase, the various complications above alluded to. The second presents many attractions, and is, perhaps, the correct mode of dealing with the matter; but, unfortunately, life is not long enough to enable men successfully to trace the origin of every term they employ, it is not always possible to do so, and if the original sense be ascertained it may often be one that has been wholly abandoned. The third mode is also very attractive to an author, it is one which he has a natural longing to adopt, and which, in some cases, must certainly be adopted, but it has the material disadvantage that what seems to oneself to be the proper and natural sense may not equally commend itself to another mind; the reading may appear

overstrained, and, after all, although it is highly desirable that technical terms should be apt, yet the main point is that they should be certain, *i.e.* that we should clearly understand what is intended to be expressed by them. These two last methods are also open to a very serious objection, which can only be avoided by the fourth mode; this objection is that anyone using the book, and referring to the works of other writers, will find the same term differently employed, and, probably not apprehending this immediately, he will have great difficulty in reconciling what he finds in the two books, and will give their authors credit for either divergences, or harmonies of opinion which never really existed. Unfortunately there are numerous instances in which the principal writers upon the *Acarina* have used terms in a sense different from that given to the same word by writers on other branches of zoology; and if I were to adopt the sense used by writers on other groups, then this book would not correspond with foreign treatises upon the *Acarina*. I have therefore, not without doubt, come to the conclusion that nomenclature, like practical optics, is a science of compromises, and that it is best, when possible, to use a term in the same sense as that employed by former writers on the same order, unless this appears to oneself to involve some manifest error, even although in one's own opinion the expression may not be happily employed. I have, in accordance with this view, endeavoured, as far as I could, to employ terms in the mode adopted by previous naturalists studying the *Acarina*, unless I saw some substantial reason for not doing so. I have, however, added a glossary, giving, as far as I can succeed in doing so, a definition of the sense in which each doubtful term is used in this book.

I will now give a few examples of the different use of terms above spoken of.

The word *epimeron* is one of some importance in the terminology of *Acarina*, because it has been largely used by certain very eminent writers, and at least

one of these has employed it to express what he relies on as one of the main structural facts by which he divides the order into families, or larger divisions, in one of the best classifications yet published. These authors are M. Charles Robin and Dr. Fumose of Paris, M. P. Mégnin of Verseilles, the late Edouard Claparède of Geneva, Dr. R. Bucholz of Dresden, &c. These writers, who are certainly sufficiently high authorities, all use the word *epimera* to signify certain chitinous bands or bars, of irregular shape, embedded in the sternal cuticle, and which form supports for the coxæ of the legs, and are themselves frequently connected with a sternum or mid-sternal ridge, or with other chitinous pieces which are connected therewith. M. Robin does not leave us in any doubt as to his meaning, for in one of his works* he gives the following footnote:—"L'épimère est cette pièce unique de chaque côté, ou accompagnée d'autres parties, avec laquelle s'articule la hanche des pattes chez les animaux articulés." This, however, does not agree with the sense in which the word epimeron is used by writers upon the Crustacea, such as Milne Edwards, Huxley,† &c. The epimera of a cray-fish are plates lying outside the insertions of the coxæ and between them and the pleuræ, and in Dunman's glossary of biological terms an epimeron is stated to be, "in the Crustacea, that part of the lateral wall of a somite which is situated external to the articulation of the appendage."

Among entomologists, Andouin‡ and Macleay§ used épimère and epimerum more in Robin's sense, for the support of the coxa, being the part which Burmeister‖ called omium in the prothorax, scapula in the mesothorax, and parapleuron in the metathorax.

* "Mémoire anatomique et zoologique sur les Acariens des genres Cheyletus, Glyciphagus, et Tyroglyphus," 'Robin's Journal de l'anatomie et de la physiologie,' 1867.

† 'The Crayfish,' 1880, p. 143.

‡ 'Ann. Sci. Nat.,' t. i, pp. 97—416, 1824.

§ 'Zoological Journal,' vol. v, p. 145, 1830.

‖ 'Manual of Entomology,' English translation, 1836.

The use of the term epimeron as applied to the part in *Acarina*, for which Robin and others use it, is probably due to Dujardin,* who first maintained its identity with the part called épimère in insects. I have thought it best upon the whole for the purposes of this work to follow the writers upon the *Acarina*, and not those on Crustacea in the use of this term.

Another word used in different senses by acarologists and entomologists is *vertex*, a word the original meaning of which is doubtless the crown of the head; and this is the sense in which it is used by Burmeister, who says:† "Vertex is the upper flattened portion of the head, upon which very generally the simple eyes or ocelli are placed." The term is thus used by Mr. E. C. Rye‡ for the space between the occiput and the clypeus. This part appears to be included in the epicranium of Huxley.§ Nicolet‖ uses the expression "vertex" for the whole dorsal surface of the cephalothorax, not including the rostrum; his hairs of the vertex, or interstigmatic hairs—for he uses the two expressions indifferently—are placed near the posterior margin of the cephalothorax almost at its junction with the abdomen; this is evidently a different thing from the crown of the head proper. What Nicolet calls vertex Claparède calls *Vorderschild*. In this book where I have used the expression "vertex" at all, I have added dorso, treating "dorso-vertex" as corresponding to cephalo-thorax, and have employed the compound term in Nicolet's sense.

Another matter in which authors use different names is the identification of the joints of the legs: and first, as to the word "joint," I employ it, not because I like it, but because it has been habitually used by English

* 'Observateur au Microscope,' Paris, 1843, p. 147.

† Op. cit., p. 50.

‡ 'British Beetles,' p. 22, 1866.

§ 'A Manual of the Anatomy of Invertebrated Animals,' London, 1877, pp. 401, 426.

‖ "Hist. nat. des Acariens qui se trouvent aux environs de Paris," 'Archives du Muséum,' t. vii, p. 381, 1855.

writers; it seems to me uncertain, because it may mean either the articulation or the portion of the appendage between two articulations. I prefer the French expression, "pièce," but in this work I have used the expression "articulation" for what we may call the actual hinge, and "joint" for a *moveable* portion of the appendage lying between two articulations, or, in the case of the distal joint, beyond the last articulation.

The various names which authors have given to the joints of the legs in *Acarina* arise doubtless in many cases from differences of opinion as to homologies, and not from mere diversities of nomenclature. Thus Nicolet treats the claws, *ungues*, as a joint, which he calls the tarsus; Nicolet's tarsus is thus different from the tarsus of other writers, except Donnadieu,* and does not agree with the nomenclature used relative to insects. I have not followed Nicolet in this respect. In order to make up for this additional joint Nicolet treats as a metatarsus what other writers call the tarsus. Lanquetin and Robin, on the contrary, use metatarsus only for the penultimate joint in those *Acarina* which have seven joints to the leg exclusive of the ungues. By the above-described mode of dealing with the claws and distal joint of the leg, Nicolet brings his tibia to the same joint which most writers distinguish by that name; but here again we find a discrepancy in some writers, like Robin, calling this joint "la jambe," and reserving tibia for the sense in which Savigny used it, namely, for the joint next to the metatarsus (or tarsus) in those *Acarina* having at least six joints to the leg, where he considers that the sixth joint is produced by the division into two of the joint called jambe by Robin and tibia by Nicolet. The proximal one of the two joints produced by this division, Savigny, Fumose, and Robin call the genual, which term is again used by Nicolet to represent not the genual of Savigny, but the third moveable joint which Robin and others call the

* 'Recherches pour servir à l'histoire des Tétranyques,' Lyons, 1875.

femur or femoral, and Donnadieu first article. The second moveable joint is called trochanter by Robin and others, but is called femoral by Nicolet and condyle by Donnadieu, Pagenstecher, and Dugès. The first moveable joint is called hanche or rotule by Robin, Dugès, and Dujardin, it is called exinguinal by Nicolet, trochanter by Pagenstecher, and racine du membre by Donnadieu.

I have, in the chapter on anatomy, given my reasons for deciding in this work to call the first moveable joint "coxa," the second "femur" (considering it to be composed of the femur and trochanter undivided), the third "genual," the fourth "tibia," and the fifth "tarsus." This seems to me to carry out the analogies of the joints, and to present to the mind a name which, in its ordinary sense, will at once convey the idea of what the office of the joint really is; and, where the best authorities disagree so widely, and the homologies are, to say the least, doubtful, I think one may be excused for preferring the analogies.

The following table relative to the nomenclature of the different joints of the leg may be useful to those consulting various authors:

Author.	1st moveable joint.	2nd moveable joint.	3rd moveable joint.	4th moveable joint.	5th moveable joint.
Pagenstecher	Trochanter	Femoral	—	—	Tarsus
Dugès	Trochanter	Femoral	La jambe	—	Tarsus
Robin, Fumose, Mégnin	Hanche or rotule	Trochanter	Femur	Jambe	Tarsus
Michael (earlier papers)	Coxa	Trochanter	Femur	4th joint	Tarsus
Nicolet	Exinguinal	Femoral	Genual	Tibia	Metatarsus
Donnadieu	Racine du membre (this, however, is not moveable)	Condyle	1st article	2nd article	3rd article
Michael (this book)	Coxa	Femur	Genual	Tibia	Tarsus
Dujardin	Hanche	—	—	—	—

CHAPTER III.

THE HISTORY OF LITERATURE RELATIVE TO ORIBATIDÆ.

This chapter will necessarily be a short one, for the material is scanty. I had thought, therefore, of combining this with the next, but it may probably be more convenient to those using this as a book of reference to have their attention drawn to such authorities as exist in a short separate record, not complicated by the more elaborate subject of classification. Moreover, some of the books serviceable to the student do not touch upon classification.

It may be stated at once that (exclusive of my own former papers) there are only two serious attempts, in any language, to deal with the *Oribatidæ* of any country as a whole; the other writings are scattered references to particular species. These two works are the undermentioned monographs by Koch and Nicolet; including, in the former, the two works which that author has left us on the subject.

Linneus* notices only one or two species; he does not separate them from other *Acarina*.

De Geer† has noticed some two or three species; one, which he calls *Corticalis*, Nicolet supposes to be *Damæus geniculatus*, but this I doubt, and another, evidently an *Oribata*, of which the species is not distinguishable.

Geoffroy‡ noticed some very few species, chiefly those which had been noticed before.

* 'Systema Naturæ,' vol. ii, 1735. 'Fauna succica,' 2nd edit., 1761 (really due to Latreille).

† 'Mémoire pour servir à l'hist. nat. des insectes,' Stockholm, 1778.

‡ 'Histoire des insectes des environs de Paris,' 1764.

Schrank* also notices much the same species.

Latreille, in his various works, which are referred to more in detail in the next chapter, was the first, as will be there seen, to attempt a classification of the *Acarina* on something approaching to the modern system, and in some of his works may be found references to several species of *Oribatidæ*.†

In 1804 the work of Hermann‡ was published; in this several species were well figured; indeed, the figures are so good that, although the descriptions are often imperfect, there can be but little doubt about any of Hermann's species, and it was a remarkable production for the date.

Dugès,§ who has been the foundation of so much of our knowledge of the *Acarina*, treated the *Oribatidæ* more shortly than any other family; indeed, with the exception of what we now call *Hoplophora*, he contributed but little to the history of this particular division.

It is now the time to notice C. L. Koch's great work,‖ which is at once the principal book of reference and the terror of the acarologist. The work is a marvel of human industry. Koch, in addition to the other orders which he treats of, collected a number of species of *Acarina* of all families, such as probably no naturalist has ever captured before or since; he figured (with coloured figures) and described everything he got, and he named and classified them. I firmly believe that his drawings and descriptions are all honestly taken from living or lately captured specimens, all from the neighbourhood of Regensburg and the naturalist would be rash, indeed, who ventured to name, as newly discovered, one of the *Acarina*

* 'Enum. Ins. Austriæ indig.;' Augusta Vindlicorum., 1781.

† 'Hist. nat. des crustacés et des insectes,' t. vii, 400.

‡ 'Mémoire aptérologique,' Strasbourg, 1804, in fol.

§ "Recherches sur l'ordre des acariens," 'Ann. Sci. nat.,' 1839, three memoirs.

‖ 'Deutschlands Crustaceen, Miriapoden und Arachniden,' Regensburg, 1834-9; forming Hefts 1 to 40 of Heinrich Schäfer's 'German Insects.'

of any family, without first searching Koch to see if he had found it; but, unfortunately, the extent of Koch's labours prevented his giving the close attention to each species necessary to distinguish it from others; every specimen which he caught, and which differed in any degree from what he had found before, was immediately named and figured, without stopping to ascertain whether it was a mature or simply a nymphal form, or whether it was only one sex of a creature, the other sex of which had already been recorded; nor did the matter stop here, for Koch sometimes made two or three species out of the identical nymph at different ages, and he made species from differences of colour due only to the food which the creature had been eating last, and from other equally unimportant matters. This is extremely puzzling to the student. It has already been pointed out by other writers. I have, in this book, endeavoured to identify Koch's species, and to show synonyms as far as I have been able; but the reader must remember that when any species, except a very strongly marked one, is referred to Koch, it does not mean more than that there is a reasonable ground for believing that the species found in England is Koch's species, and that I have given the foreign author the benefit of the doubt, as I always endeavour to do. Koch's figures and descriptions are not sufficiently exact to enable one to speak with certainty.

Koch's 'Deutschlands Crustaceen,' &c., does not contain any classification or description of genera, but he wrote a subsequent work to supply the deficiency.* This book is the foundation of most of our modern genera; but, if the 'Deutschland's Crustaceen' be confusing from its number of species, the 'Arachnidensystem' is equally troublesome from the vagueness of definitions of genera; Koch certainly had not a genius for classification, or, if he had, he did not exhibit it in his descriptions of the generic characters of *Oribatidæ*.

* 'Uebersicht des Arachnidensystems,' Nürnberg, 1837 to 1850.

I confess that I fail to draw any clear ideas from his definitions; I should probably think that this was my fault if such writers as Nicolet, Robin, and Mégnin had not remarked the same thing before me. The result of this is that many of his genera, such as *Nothrus*, *Oribates*, &c., are singular assemblages of heterogeneous creatures, while other genera are formed of beings so alike that it is far from easy to understand what Koch intended by the division; again, a third group of genera, such as *Murcia* and *Celæno*, are wholly composed of immature (nymphal) forms. It must not be supposed that I blame Koch for this, it is often most difficult to decide whether a creature is a nymph or an imago, and, in Koch's day, it must have been more difficult still; even now it is only the crucial test of breeding which seems to me to be reliable. There cannot be the least doubt that Koch had an idea, well enough marked in his own mind, of the group which he intended to include in each genus, but I think he has failed to convey his meaning to his readers. We all make errors, and this is one committed by a man who was a thorough lover of nature and a most industrious naturalist.

A very different class of monograph was M. H. Nicolet's;* he commenced with the idea of monographing the *Acarina* of the Paris district in Milne-Edward's series of museum publications; but, like others who have had a similar notion, he found the subject too large for him, he never got beyond the *Oribatidæ*, and unless the French *Oribatidæ* are considerably less numerous than the English, which is scarcely probable, he only dealt with a portion of these. He gives but eleven of the immature forms, and of these at least two are errors; in spite of these points and many others in which I cannot agree with him, the book is admirable, and what he has done is well and clearly done. There is not any doubt about

* "Histoire naturelle des Acariens qui se trouvent aux environs de Paris," 'Archives du Muséum,' t. vii, 1855.

the definition of his genera, although subsequent discoveries may have rendered some of them no longer available. His plates are beautiful, with ample detail, and engraved regardless of expense. His anatomy was a great step in advance, and forms the bulk of the record on the subject up to this time; the whole book is one that a biologist of the present day might well be proud to have written.

Edward Claparède, of Geneva, also started with the intention of dealing in an exhaustive manner with the *Acarina*; he, however, soon drew back appalled at the vast extent of the subject he had entered on. He has left behind him, as the result of his labours, his 'Studien an Acariden.'* It is a series of papers upon various species of different families; it works out a few species, paying special attention to the development and anatomy; it occupies a hundred closely printed octavo pages, and is illustrated by eleven large-sized coloured plates; both letterpress and plates are some of the best work ever done upon the subject of *Acarina*. It is not any reflection upon its very able and careful author to say that there are numerous errors in it, it is the fate of all men entering upon a comparatively unworked and difficult field of labour, to make errors.

One of his papers treats of a single species of the family of *Oribatidæ*, viz. *Hoplophora contractilis* as he calls it, the species being apparently the same as Dugès' *H. dasypus*, which is the older name. The paper is admirable, but unfortunately it has been supposed that what he says about *Hoplophora* is necessarily true about other genera, which is far from being the case.

We are indebted to Af. T. Thörell, of Stockholm, for a description of several *Acarina*, chiefly *Oribatidæ*, found at Bell's Sound Spitzbergen, and Beeren Island.†

Dr. G. Haller, of Bern, has added a few observations

* 'Zeit. für wiss. Zool.,' 1868, p. 445.

† 'Oefversight af Kongl. Vetenskaps-Akademiens Förhandl.,' 1871.

on the habits of *Oribatidæ*.* I am not quite able to agree in all of them, as will appear hereafter, but they are well worthy of attention.

Professor G. Canestrini, F. Fanzago, and A. Berlese, of Padua, have recorded some Italian species,† but I have not found any of their new species in England.

Riley‡ has recorded one or two American species and particularly *Hoplophora arctata*, a curious species found at the root of the vine.

Gervais,§ in Walckenaer's 'Aptères,' treats of the *Oribatidæ* amongst other things; his work is extremely useful, but does not profess to contain much original matter.

I am not aware of anything else which I can fairly call bibliography upon the *Oribatidæ*, but the student of their anatomy, development, or habits would be far from wise if he neglected works upon allied families, such, for instance, as the admirable joint treatises upon the anatomy of certain of the *Acarina* by Drs. Fumose and Robin,‖ a work of the greatest value to the acarologist: Claparède's other papers in the collection above cited: Pagenstecher's important study of the anatomy of *Trombidium holosericum* and *Ixodes ricinus*,¶ well illustrated with coloured plates: Mégnin's valuable contributions to the subject, which contain a large amount of good original work, and have elucidated many difficult and obscure points:** Dr. Kramer's

* "Miscellanea acarinologica," 'Mittheilungen der Schweitzerischen entomologischen Gesellschaft,' vol. v, Heft 9, Schaffhausen, 1879. "Zur Kenntnis der Tyroglyphen und Verwandten," 'Zeit. wiss. Zool.,' Bd. 34, p. 256, 1879.

† "Intorno agli acari Italiani," 'Atti del R. Instituto Veneto di Sci.,' &c., Venice, 1877.

‡ 'Sixth Missouri Report,' 1874.

§ 'Hist. nat. des Insectes, Aptères,' Paris, 1844.

‖ "Mémoire Anatomique et Zoologique sur les acariens des genres Cheyletus, Glyciphagus et Tyroglyphus," 'Robin's Journal de l'anat. et de la physiol.,' Paris, 1867, pp. 506, 562. "Recherches zoologiques et anatomiques sur les glyciphages à poils palmé ou plumeux," ibid, 1868, p. 66.

¶ 'Beiträge zur Anatomie der Milben,' Leipzig, 1860.

** "Mémoire sur les Hypopus," 'Robin's Journ. de l'anat. et de la phys.,' 1874, 226. "Mémoire sur les métamorphoses des acariens," 'Ann.

'Beiträge zur Naturgeschichte der Milben,' &c.:* Prof. Cronberg's reliable works,† which unfortunately are chiefly in Russian,—and many others.

Before closing this chapter I must allude to what English naturalists have published relative to the *Oribatidæ;* it is indeed scanty and easily stated. Curtis mentions *Damæus geniculatus*, with relation to its supposed action upon trees.‡ Dr. Johnston, in his *Acarina* of Berwickshire,§ mentions the same species, and a *Carabodes nitens*, but I doubt whether it would be possible to identify it, as Johnston was not accustomed to the subject, and did not give the necessary distinctive characters, while some of those he did give can scarcely be correct. An old paper in Shaw's 'Zoological Miscellany' describes an un-identifiable species inappropriately called the "wandering mite." Mr. George has noticed the occurrence of a *Hoplophora* in England.‖ Mr. Underhill, of Oxford, figured *Notaspis lucorum* (not naming it).¶

Andrew Murray has given a short notice of some of Nicolet's and Thörell's species, not stating that they were British, but only that they might possibly be found here some day.** And there are my own papers, of which a list will be found in the bibliography at the end of this book.

des sci. nat.,' 6 sér. Zool., vol. iv, p. 1. "Mémoire sur l'organization et la distribution zoologique des acariens de la famille des Gamasides," 'Robin's Journal de l'anat.,' &c., 1876, 288. "Les Sarcoptides plumicales," ibid., 1877. "Mémoire sur le *Demodes folliculorum*," Owen, ibid., 1877. 'Les parasites et les maladies parasitaires,' Paris, 1880, &c.

* 'Zeit. für d. ges. Naturwiss.,' 1878.

† "Ueber der Bau von Trombidium," 'Bull. de la Soc. de Naturalistes de Moscow,' 1879, No. 2. "On Eylais extendens" (in Russian), ibid, 1878 (a summary in German in the Zool. Anzeiger, 1876, 316.

‡ 'Gardener's Chronicle,' 1843, p. 356.

§ "The Acarides of Berwickshire specifically described," 'Trans. of Berwickshire Naturalists' Field Club,' vol. ii, 1849, pp. 221, 289; vol. iii, 1853, p. 113.

‖ 'Science Gossip,' 1877, p. 205.

¶ 'Notes of the Postal Microscopical Club,' Decr. 19, 1877 (published 1883).

** 'Economic Entomology,' London, 1877.

CHAPTER IV.

UPON THE CLASSIFICATION OF ACARINA IN GENERAL AND THE POSITION OF THE ORIBATIDÆ THEREIN.

I HAD some doubt whether I should not omit this chapter, but it hardly seems satisfactory to commence with the classification of the Family of *Oribatidæ* without showing what position it occupies in the Order. To do this a classification of the latter must be given, and a good one in the English language is much wanted. Practically, the only one that exists is Andrew Murray's in his handbook to the Bethnal-Green Museum.* I have, at the end of this chapter, given what I hope may be acceptable as an attempt at a natural classification, and a combination of the best points in the classifications of previous authors. In order that I may not take credit for what does not belong to me, and to enable the reader to refer to the works of the various foreign writers without being confused by the endless variety of classifications, I have thought it best to give a short history of what systems various acarologists have adopted. It may fairly be objected that this is "scissors and paste," but unless we neglect all that previous naturalists have done, we must employ those two useful articles a little; it may also be objected that Gervais has done it before, but his book is not in English, it is not accessible to everyone, and the principal natural classifications have been made since Gervais's date. I therefore give the *résumé* here—no one need use it who does not find it advantageous.

* 'Economic Entomology (Aptera),' London, 1877.

Linneus* cannot be said to have classified the *Acarina* at all, he treated them all as one genus, *Acarus*. De Geer† made a first attempt at classification as follows:

	Equal in modern nomenclature to
Mites found in provisions (the domestic Mite) .	Practically *Tyroglyphidæ*.
Mites which attack men and quadrupeds . . .	,, *Sarcoptidæ*.
Mites which live on birds	,, *Analgidæ*.
Mites which live on other insects.	Chiefly *Gamasinæ* and *Hypopi*—mostly immature forms.
Mites found on trees and vegetables.	Practically *Tetranychus*, *Oribatidæ*, &c.
Wandering Mites . . .	,, *Trombidium*, &c.
Aquatic Mites	,, *Hydrachnidæ*, *Hygrobatidæ*, &c.

He gives a few species of each division.

In this somewhat quaint early classification it will be seen that De Geer has managed, in most instances, to divide the few species he knew of into groups which somewhat correspond with those now recognised, although he relies on many immature forms, and classes such widely different creatures as *Tetranychus* and the *Oribatidæ* together.

Gmelin's classification‡ was rather retrograde. He recognised only two families, or rather genera, viz. *Acarus* and *Hydrachna*, being practically land and water mites; *Trombidium* with him formed a subgenus of *Acarus*.

G. Cuvier, in 1798,§ following the method of Fabricius,‖ includes the *Hydrachnidæ* only amongst the *Arachnidæ*, which he calls *Araneides* or *Unogata*. He

* 'Systema Naturæ,' 1st ed., Lugd. Bat., 1735.

† 'Mémoires pour servir a l'hist. nat. des insectes," Stockholm, 1778, 'Act. Acad. Sc. Suec.,' 1740.

‡ 'Systema Naturæ,' 2nd edition, et post ad 1788-93, Leipsig.

§ 'Tableau élémentaire de l'hist. nat. des animaux,' Paris, an. vi, 1798.

‖ 'Systema Entomologiæ,' Flensburg, 1775.

characterises them by the possession of maxillæ and filiform palpi. The other *Acarina* he classes with *Pulex* and *Pediculus*, which he regards as being devoid of maxillæ. *Trombidium* he omits altogether.

Lamarck, in 1801,* published the following classification (the families being chiefly those of Latreille's first work referred to below), viz. "Arachnides palpistes."

EYLAIS. TROMBIDIUM	Mouth with mandibles and maxillæ.
HYDRACHNA BDELLA ACARUS	Mouth furnished with a sucker.

It is of course needless to point out now that the sucker is composed of the maxillæ (and lingua).

Latreille made the first really important step towards the modern classification of *Acarina;* several of the families bear his names, amongst others the *Oribatidæ.*

Latreille's first effort was in 1795.† He then called the *Acarina* "Tiques," and made eleven genera, viz. *Argas*, *Atomus*, *Ixodes*, *Pycnogonum*, *Bdella*, *Hydrachna*, *Trombidium*, *Acarus*, *Parasitus*, *Siro*, and *Chelifer.*

In 1797‡ Latreille published a much more elaborate classification, which I do not think it necessary to give here as it was not his final one.

Latreille, in 1806, published his most important classification,§ which was as follows:

ACARIDIDÆ	*Trombidium*, Fabricius. *Erythræus*, gen. nov. *Gamasus*, Latreille (the *Carpais* of his earlier works). *Oribata*, Latreille; type *geniculatus.* *Acarus*, for *Tyroglyphus*, Latreille; type *A. siro*, Linn.

* 'Système des animaux sans vertèbres,' Paris, an. ix, 1801.

† 'Magazin encyclopédique,' t. iv, p. 15, 1795.

‡ 'Précis des caractères génériques des insectes disposés dans un ordre naturel,' 1797.

§ 'Genera Crustaceorum et Insectorum,' Paris, 1806-9.

RICINIÆ	*Sarcoptes*, Latreille. *Cheyletes*, Latreille. *Smaris*, Latreille; for *A. Sambuci*, Schrank. *Bdella*, Latreille; for *Acarus longicornis*, Linn. *Argas*, Latreille. *Ixodes*, Latreille. *Uropoda*, gen. nov.
HYDRACHNELLÆ (Aquatic Mites)	*Eylais*, Latreille; for *Hydrachna extendens*, Muller. *Hydrachna*, Muller; type *H. cruenta*, Muller. *Limnocares*, Latreille; for *A. aquaticus*, Linn.
MICROPHTIRA (6-legged Mites)	*Caris*, Latreille (probably a larva of *Pteroptus*.) *Leptus*, Latreille; for *Acarus phalangii*, a larva of *Trombidium*. *Astoma* (*Acarus parasiticus*), De Geer.

It will be seen from the above how many of our modern genera and families are due to Latreille. It is strange that anyone who divided into genera so well should have grouped those genera into families in so very incongruous a manner; as, for instance, separating *Gamasus* from *Uropoda*, *Trombidium* and *Erythæus* from *Smaris* and *Bdella*, and *Acarus* from *Sarcoptes*, while his fourth family consists entirely of larvæ.

In his earlier work Latreille takes *geniculatus* as the type of *Acarus*, this is the same species which he subsequently makes the type of *Oribata*.

Hermann's excellent work* appeared in 1804, although the greater part of it was written at a considerably earlier date; he calls the *Acarina* "*Holetra*,"† and includes in this the *Phalangidæ* and *Pycnogonidæ*. His classification is—

* 'Mémoire Aptèrologique,' in fol., Strasbourg, an. xii, 1804.
† ὅλος, entire ; ἦτρον, abdomen.

1st. Naked, conical, tubulated			*Pycnogonum.*
*a**. With palpi; not chelate; rostrum	covered by two sheathing blades	entire	*Hydrachna.*
		serrated	*Rhynchoprion* (=*Argas*, Latr.)
	mandibles unguicular		*Trombidium.*
**. Palpi chelate, the digits	adpressed		*Acarus.*
	transverse		*Phalangium.*
b. With antennæ	straight and clavate		*Cynorhoestes* =*Ixodes*, Latr.
	bent, ending in two hairs		*Scirus* =*Bdella*, Latr.
2nd. Back covered by a shield			*Notaspis.* =*Oribata*, Latr.

The division of *Notaspis* from the rest of the *Acarina* here was certainly good; and *Hydrachna* and *Trombidium* are properly classed together, but the separation of "*Scirus*" (*Bdella*) from them is scarcely natural, nor is the separation of *Argas* from *Ixodes*. It may also be remarked that he uses the expression palpus for the mandibles and antennæ for palpi, while his mandibles also are really palpi. In spite of these things it must be admitted that Hermann had excellent ideas of classification.

William Elford Leach,* in 1815, published a classification; he calls the *Acarina*, *Monomerosomata*, and divides them into seven families, viz.:

TROMBIDIDES	1.	*Trombidium*, Fabr.
		Ocypete, Leach.
	2.	*Erythræus*, Latr.
GAMASIDES		*Gamasus*, Latr.
ACARIDES		*Oribata*, Latr.
		Acarus, Linn. confined to the true *Acari*.
IXODIDES	1.	*Argas*, Latr.
		Ixodes, Latr.
	2.	*Uropoda*, Latr.
CHEYLETIDES		*Cheyletus*, Latr.
		Smaris, Latr.
		Bdella, Latr.
		Sarcoptes, Latr.

* 'Trans. Linnean Society, London,' vol. xi, 387, 1815.

EYLAIDES	*Eylais*, Latr.
HYDRACHNIDES	{ *Hydrachna*, Mull. *Limnochares*, Latr.

There is a good deal to be said in favour of this arrangement, although certainly *Uropoda* belongs to *Gamasides* not to *Ixodidæ*, *Sarcoptes* does not belong to *Cheyletidæ*, and *Oribata* is not properly joined to *Acarus*.

C. von Heyden in 1828 published the next classification which need be noticed.* It would really seem as if his object had been to upset all that had gone before him, and to establish a permanent stumbling-block in the way of future arachnologists. This paper was only a synopsis of a larger work which was to have appeared subsequently, but which was never published. He makes a large number of new genera, gives fresh names to almost all the old ones, or splits them up into several genera; and he does not define any of his new genera, or his divisions of the old ones, exactly, so that it is impossible to know what he intended; and yet we cannot altogether neglect his classification because his names of certain genera have been adopted, and some writers have used his names instead of those now more usually employed.

Von Heyden had the notion of dividing his mites into Legions and Phalanges, and he managed it in the following manner:

LEGION 1 (with eight legs).

Phalanx 1 (with eyes).

a. 1. *Bdella* (Latr.), type *B. rubra*. 2. *Cyta*, gen. nov., type *Sc. latirostris* (Herm.). 3. *Cunaxa*, gen. nov., type *Sc. setirostris* (Herm.).

b. 4. *Trombidium*, type *T. holosericum*. 5. *Behaustium*, gen. nov., type *Tr. murorum* (Herm.).

* "Versuch einer systematischen Eintheilung der Acariden," 'Oken's Isis,' 1828.

c. 6. *Erythræus*, Latr., type *E. phalangioides.* 7. *Fessonia*, gen. nov., type *Tr. papillosum*, Herm. 8. *Amystis*, gen. nov., type *Tr. cornigerum*, Herm. 9. *Smaris*, Latr. 10. *Gausapa*, gen. nov. (no type). 11. *Gambula*, gen. nov. (no type).

Phalanx 2 (without eyes).

a. 12. *Nura*, gen. nov. (no type). *Parastata*, gen. nov. (no type). 14. *Gamasus*, Latr. 15. *Syrma*, gen. nov. (no type). 16. *Ollicula*, gen. nov. (no type). 17. *Ixodes*, Latr. 18. *Cheyletus*, Latr. 19. *Odopeta*, gen. nov. (no type). 20. *Tribon*, gen. nov. (no type). 21. *Asca*, gen. nov. (no type). 22. *Voltula*, gen. nov. (no type). 23. *Galba*, gen. nov. (no type). 24. *Corbylus*, gen. nov. (no type). 25. *Tylos*, gen. nov. (no type).

b. *Clunus*, gen. nov. (no type). 27. *Analges*, Nitzsch (=*Dermaleichus*, Koch).

c. 28. *Sarcoptes*, Latr. 29. *Acarus*, Lin. 30. *Tergilla*, gen. nov. (no type). 31. *Offula*, gen. nov. (no type). 32. *Tryla*, gen. nov. (no type). 33. *Lygdenus*, gen. nov. (no type). 34. *Itrium*, gen. nov. (no type).

d. 35. *Cryptopeza*, gen. nov. (no type). 36. *Oluris*, gen. nov. (no type). 37. *Abella*, gen. nov. (no type). 38. *Balluca*, gen. nov. (no type). 39. *Zura*, gen. nov. (no type). 40. *Lorax*, gen. nov. (no type). 41. *Belba*, type *Notaspis corynopus*, Herm., =*Damæus*, Koch, and part of *Oppia*, Koch. 42. *Rox*, gen. nov. (no type). 43. *Liodes*, gen. nov., type *Notaspis theleproctus*, Herm. = part of *Nothrus*, Koch. 44. *Panda*, gen. nov. (no type). 45. *Oribata*, Latr. 46. *Saburra*, gen. nov. (no type). 47. *Camisia*, gen. nov. (no type). 48. *Fadus*, gen. nov. (no type).

e. 49. *Spinturnix*, gen. nov., type *Acarus vespertilionis* = *Pteroptus*, Dufour. 50. *Argas*, Latr. 51. *Lipostomus*, Nitzch. 52. *Uropoda*, Latr. 53. *Cetra*, gen. nov. 54. *Panoplia*, gen. nov., type *A. denticu-*

latus, Schrank. 55. *Ciccum*, gen. nov. (no type). 56. *Mycelum*, gen. nov. (no type). 57. *Galumna*, gen. nov., type *Notaspis alatus*, Herm. = a part of *Oribata*, Latr., being the typical part. 58. *Cillibano*, gen. nov., type *Notaspis cassideus*, Herm. (really a *Uropoda*).

LEGION 2 (with six legs).

a. 59. *Leptus*, Latr. 60. *Cnodax*, gen. nov. (no type). 61. *Rescula*, gen. nov. (no type). 62. *Ocypete*, Leach.

b. 63. *Trochiscus*, gen. nov. (no type). 64. *Myobia*, gen. nov., type *Pediculus musculi*, Schrank. 65. *Caris*, Latr. 66. *Achlysia*, Audouin.

LEGION 3 (with eight legs, aquatic).

67. *Eylaïs*, Latr. 68. *Hydrachna*, Mull. 69. *Limnochares*, Latr.

Of this classification the greater part of Legion 2 are larvæ; but *Myobia*, the genus by which Heyden is perhaps principally known, is not hexapod but octopod, although the first pair of legs are very unusual in form. *Argas* is separated from *Ixodes*, *Pteroptus* from *Gamasus*, &c., while *Oribata* and *Uropoda* figure twice over, under different names.

Dr. C. J. Sundvall,* in 1833, published his little pamphlet, in which he makes the following classification:

Family 1.—HYDRACHNIDES. Aquatic, with eight natorial feet. *Eylaïs*, *Hydrachna*, *Limnocares*.

Family 2.—TROMBIDIDES. Eight cursorial feet; palpi of five joints, penultimate produced beyond insertion of ultimate joint; ultimate joint free and dependent; maxillæ absent; mandibles simple, acute. *Trombidium*, *Erethræus*.

Family 3.—GAMASIDES. Eight cursorial legs; palpi naked, 5-jointed, long, curved, passing the rostrum,

* 'Conspectus Arachnidum,' Lund. In Acad. Carolina, 1833.

very mobile. *Scirus* (*Bdella*), *Cheyletus*, *Gamasus* (for the soft species), *Carpaïs* (for the hard ones), *Pteroptus*, *Macrocheles*, Latr.?

Family 4.—SARCOPTIDES. Eight gressorial legs; palpi absent or anchylosed to rostrum; mandibles chelate. *Notaspis*, Herm. = *Oribata*, Latr.; *Sarcoptes*, Latr.; *Tetranychus*, Duf.

Family 5.—IXODIDES. Eight gressorial legs; palpi straight, 2- to 4-jointed; rostrum and mandibles serrated, powerful. *Ixodes*, *Argas*.

Family 6.—LEPTIDES. Six legs in the adult state; *Caris*, *Leptus*, *Ocypeta*, *Astoma*, *Achlysia*.

In this classification, which has many very good points, Family 6 are entirely larvæ, and Family 4 is not a happy grouping; this arises greatly from his confusing the trophi one with another.

We come now to what may probably be considered as the commencement of the modern classification of *Acarina*, viz. that of Dugés, published in 1839.* It must be confessed that this classification is highly artificial, and yet Dugès managed to divide the *Acarina* by it into groups which are mostly natural, and have, on the whole, stood the test of time. He divides them into seven families composed of twenty genera; his method is as follows:

Family 1.—TROMBIDIEI. Palpi raptorial.

Tetranychus, Duf., *Pachygnathus*, gen. nov.; *Raphignathus*, gen nov., type *Trombidium lapidum*, Herm.; *Megamerus*, gen. nov., type *Trombidium longipes*, Herm.; *Smaridia*, *Rhyncholophus*, gen. nov., type *Tromb. phalangioides*, Herm.; *Trombidium*, *Erythræus*.

Family 2.—HYDRACHNEI. Palpi anchoring.

Diplodontus, gen. nov., *Atax*, *Arrenurus*, gen. nov. for *H. albator*, &c.; *Eylaïs*, *Limnocares*, *Hydrachna*.

* "Recherches sur l'ordre des Acariens," 'Ann. sci. nat.,' 2nd series, Zool., vol. i, 1839.

Family 3.—GAMASEI. Palpi filiform.
Dermanyssus, gen. nov., type *Acarus gallinæ*, de Geer, *Gamasus*, *Uropoda*, *Pteroptus*, *Argas*.
Family 4.—IXODEI. Palpi valvular.
Ixodes.
Family 5.—ACAREI. Palpi adherent (to the labium).
Hypopus, gen. nov., type *Acarus spinipes*, Herm.; *Sarcoptes*, *Acarus*.
Family 6.—BDELLEI. Palpi antenniform.
Bdella, type *Scirus vulgaris*, Herm.; *Scirus*, type *S. setirostris*, Herm.
Family 7.—ORIBATEI. Palpi fusiform.
Oribates.

In this classification many of the smaller groups, as for instance *Cheyletus*, are omitted. The raptorial palpi are those where the penultimate joint projects beyond the articulation with the ultimate one, which latter is soft, rounded, and moveable. The anchoring palpi are those where the ultimate joint is curved, pointed, and moveable, and is articulated with the distal end of the penultimate joint. The valvular palpi are flattened with concave inner sides.

Koch followed, in 1842;* he made a very large number of new genera, which it would occupy too much space to set out, but his main classification was as follows:

ORDER—ACARI.

1*st Division*.—Water-mites. Legs 7-jointed with flexible swimming hairs.
Family 1.—HYGROBATIDES. With 2 eyes.
Family 2.—HYDRACHNIDES. With 4 eyes.
2*nd Division*.—Mud-mites (*Limnocaridæ*). Legs 7-jointed, two hinder pairs widely separated from the two front pairs.

* 'Uebersicht des Arachnidensystems.' Nürnberg, 1842.

3rd Division.—Earth-mites. Legs 7-jointed, no swimming hairs, jaws with a single hook.

Family 1.—TROMBIDIDES. Raptorial palpi; eyes on an angle at the side of the mouth.

Family 2.—RHYNCHOLOPHIDES. Eyes on the dorsum of the cephalothorax.

4th Division.—Running mites. Legs 6-jointed; jaws chelate.

Family 1.—EUPODIDES. Two small eyes; front legs longer than the others.

Family 2.—BDELLIDES. With 4 eyes; palpi at the side of rostrum, moveable sideways.

Family 3.—GAMASIDES. Eyeless; mouth-parts moveable, backward and forward; palpi fusiform.

Family 4.—CARABODIDES (=ORIBATIDÆ). Beetle-shaped, cephalothorax and abdomen plainly divided, palpi usually hidden.

Family 5.—SARCOPTIDES. Louse-like mites. The sucking rostrum entirely, and the palpi chiefly, concealed; legs usually dissimilar, with or without suckers; living on animals. This family includes *Acarus*, *Homopus*, *Sarcoptes*, *Dermaleichus* (*Analges*), *Pteroptus*, *Uropoda*, *Hypopus*.

Koch makes the *Ixodes* and *Argasides* into a separate order, under the name of *Ricini;* his definitions will not always be found to be accurate for the species and genera which he includes in the families. Thus *Sarcoptides* is a strange group, and *Pteroptus* and *Uropoda* certainly belong to the *Gamasides*.

Gervais, in 1844,* adopted a very simple classification; he treated the families as genera and made seven main groups. He did not exactly aim at original definitions, but rather at a summary of what others had done. His seven main genera are *Bdella*, Latr.,

* In Walckenaer's 'Histoire naturelle des Insectes; Aptères,' Paris, vol. iii, 1844.

Trombidium, Fabr., *Hydrachna*, Müller, *Gamasus*, Latr., *Ixodes*, Latr., *Tyroglyphus*, Latr., *Oribates*, Latr. His definitions are intentionally often rather descriptions and are long. He mentions also some of the smaller genera of other authors.

M. H. Nicolet, in 1855, published the work* alluded to in Chapter III of this book. In his preface he gives the following classification, which has been largely followed.

ACARIENS.

Aerial or Terrestrial	ORIBATIDES = *Oribates*, Latr. GAMASIDES = *Gamasus*, Latr., *Uropoda*, Latr. ACARIDES = *Acarus*, *Sarcoptes*, &c. IXODIDES. TROMBIDIDES = *Trombidium*, *Bdella*, &c.
Aquatic	HYDRACHNIDES = *Hydrachnides* and other swimming *Acarina*. DEMODIDES = *Demodex*, *Tardigradia*, and all other *Acarina* which live in liquid, but do not swim.

There cannot be any doubt that this short classification has a great amount of what is valuable in it, and that the groups are, on the whole, natural, although, as stated further on, I object to the division into aquatic and terrestrial, and to some other points. Unfortunately Nicolet did not live to work it out, except in the single instance of the *Oribatidæ;* had he done so it would assuredly have been carefully executed.

M. H. Fürstenberg, of Eldena, near Greifswald, in 1861 published his great work on the itch-mites.† It contains the following classification:

* "Hist. Nat. des Acariens qui se trouvent aux environs de Paris," 'Archives du Muséum,' t. vii, 1855.

† 'Die Krätzmilben der Menschen und Thiere.' Leipzig, 1861.

ORDER I.—MITES.—*ACARINÆ*.

Division 1.—WATER-MITES.

Family 1.—Sea-mites,* PYCNOGONIDES.
Genera.—Pycnogonum, Phoxichilidium, Nymphon, Ammothoë.
Family 2.—River-mites, HYGROBATIDES.
Genera.—Atax, Nesæa, Piona, Hygrobates, Hydrochreutes, Arrenurus, Atractides, Acerus, Diplodontus, Marica.
Family 3.—Pond-mites, HYDRACHNIDES.
Genera.—Limnesia, Hydrachna, Hydryphantes, Hydrodroma, Eylaïs.

Division 2.—MUD-MITES.

Genera.—Limnocares, Thyas, Smaris, Alycus.

Division 3.—LAND MITES.

Family 1.—Undivided Mites, TROMBIDIDES.
Genus.—Trombidium.
Family 2.—Ornamented Mites, RHYNCHOLOPHIDES.
Genera.—Rhyncholophus, Smaridia, Erythræus, Stigmæus, Caligonus, Raphignatus, Actineda, Tetranychus.

Division 4.—CURSORY MITES.

Family 1.—Beautiful Mites, EUPODIDES.
Genera.—Bryobia, Scyphius, Penthaleus, Linopodes, Eupodes, Tydeus.
Family 2.—Snouted Mites, BDELLIDES.
Genera.—Bdella, Ammonia, Scirus, Eupalus, Cheyletus.
Family 3.—Animal Mites (parasites), GAMASIDES.
Genera.—Dermanyssus, Gamasus, Lælaps, Zercon, Sejur, Notaspis, Eumeus.
Family 4.—Beetle Mites, CARABODIDES.
Genera.—Oribates, Zetes, Eremæus, Pelops,

* The English names are translations of the German, not of the scientific names.

Cepheus, *Oppia*, *Damæus*, *Carabodes*, *Celæno*, *Hypochthonius*, *Nothrus*, *Murcia*, *Hoplophora*.

Family 5.—Louse-mites, Sarcoptides.

Genera.—*Sarcoptes*, *Dermatophagus*, *Dermatokoptes*, *Dermaleichus*, *Homopus*, *Pteroptus*, *Hypopus*, *Acarus*, *Uropoda*.

ORDER II.—TICKS.—*RICINI*.

Family 1.—Argasides.

Genera.—*Ornithodorus*, *Argas*.

Family 2.—Ixodides.

Genera.—*Hyalomma*, *Hæmalastor*, *Amblyomma*, *Ixodes*.

Family 3.—Rhipistomides.

Genera.—*Dermacentor*, *Hæmaphysalis*, *Rhipicephalus*, *Rhipistoma*.

No one will deny that there is considerable merit in this classification, but the author seems to have relied too entirely on Koch's genera, which are not altogether reliable. The creatures composing Order I differ more one from another than some of them do from those in Order II. Habitat would appear to be too strictly followed, *e.g.* it is hard to find any real analogy between the *Pycnogonidæ* and the *Hydrachnidæ*, and *Trombidium* is more like *Rhyncholophus* than it is like *Oribata*. *Tetranychus* would appear to be more allied to *Bryobia* than to *Erethræus*, &c. Again, the genus *Uropoda* figures twice, once under that name among the *Sarcoptides*, whereas it clearly belongs to the *Gamasidæ*, and once in its proper place under the name of *Notaspis*. This is the same error that Koch made. *Pteroptus* also is placed among *Sarcoptidæ*, whereas it belongs to *Gamasidæ*.

A. L. Donnadieu, of Lyons, in 1875,* attempted a natural classification of the *Acarina*. In his main division he followed Nicolet, thus :

* 'Recherches pour servir à l'histoire des Tetranyques.' Lyons and Paris, 1875.

ACARIENS.

Aërial	HOMOPODES	with integument hardened	entirely	Oribatidés (*sic*).
			partly	Ixodidés (including Argas).
				Gamasidés.
		integument soft		Trombidionidés.
				Sciridés.
				Tétranycidés.
				Tyroglyphidés.
	HÉTÉROPODES	with claws		Trichodactylidés.
		with suckers		Sarcoptidés.
Aquatic				Hydrachnidés.
				Atacidés.

This arrangement is a highly praiseworthy effort, but, in addition to the terrestrial and aquatic question, the *Gamasididæ* have legs as different from each other as those of the greater part of the *Sarcoptidæ*, and the *Tyroglyphidæ* are far more closely allied to the *Sarcoptidæ* than to any of Donnadieu's Homopodes.

P. Mégnin, of Vincennes, in 1876,* published his important classification, which introduced some new and exceedingly good bases of differentiation; as slightly amended in a subsequent work,† this system is:

Terrestrial Acarina	Skeleton having for its basis a rigid or a membranous sternum	Legs with six joints	Stigmata with long tubular peritremes .	*Gamasidæ.*
			Stigmata with discoidal sieve-like peritremes .	*Ixodidæ.*
		Legs with five joints . .		*Oribatidæ.*
	Skeleton having epimera for its basis. Legs of five or six joints	Mandibles chelate, palpi cylindrical or conical, partly adherent to the labium; legs of five joints		*Sarcoptidæ.*
		Mandibles styliform, palpi free and antenniform; legs of six joints		*Sciridæ.*
		Mandibles blade-like or styliform, free raptorial palpi; legs of six joints		*Trombididæ.*
Aquatic or puricolous Acarina	Legs with six joints	Mandibles soldered to the sheath		*Limnocaridæ.*
		Mandibles styliform		*Hydrachnidæ.*
		Mandibles hooked		*Hygrobatidæ.*
	Legs with three joints	Without caudal prolongation .		*Arctisconidæ.*
		With vermiform caudal prolongation		*Demodicidæ.*

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* "Mémoire sur l'organization et la distribution zoologique des acariens de la famille des Gamasidés," 'Robin's Journal de l'anatomie et de la physiologie,' May, 1876.

† 'Les Parasites et les Maladies parasitaires.' Paris, 1880.

Andrew Murray, in 1877, published his work on the Aptera,* which contains the following classification:

ACARINA.—MITES.

Family 1.—TROMBIDIINÆ,† containing:
1. TETRANYCHI. Spinning-mites.
2. TROMBIDIIDÆ.† Harvest-mites.
Family 2.—BDELLIDÆ. Snouted harvest-mites.
Family 3.—HYDRACHNIDÆ. Water-mites.
Family 4.—GAMASIDÆ. Insect mite-parasites.
Family 5.—IXODIDÆ. Ticks.
Family 6.—HALICARIDÆ. Marine mites.
Family 7.—ORIBATIDÆ. Beetle mites.
Family 8.—ACARIDÆ.
1. HYPODERIDÆ. Subcutaneous mites.
2. HYPOPIDÆ. Ichneumon mites.
3. TYROGLYPHIDÆ. Cheese mites.
4. SARCOPTIDÆ. Itch and louse mites.
5. PHYTOPTIDÆ. Gall mites.

This is intentionally a popular book, and does not profess to originate definitions. The families are distinguished by descriptions. It is no doubt our best English work on the subject, but leaves much to be desired; as Murray was apparently not well acquainted with the creatures from personal observation of living specimens, his English names, although in the main true and useful, are sometimes rather misleading, as, for instance, the *Gamasidæ* are by no means all parasitic. The *Halicaridæ* (*Halacarus*, Gosse), a family introduced for the first time, have freshwater as well as marine species.‡

There are other subcutaneous mites besides the *Hypoderidæ*.§

* 'Economic Entomology, Aptera;' London.

† Sic.

‡ 'Ueber die Milbengattungen Leptognathus' (Hodge), &c. Kramer, 'Archiv für Naturgeschichte,' 45th year (1879), p. 142. 'Notes on British Freshwater Mites,' Brady; 'Proceedings of the Zool. Soc. of London,' 1877, p. 25.

§ "On an Undescribed Species of Acarus found in the Pigeon," by Charles Robertson, 'Microscopical Journal,' 1866. "Les acariens

The *Hypopidæ* are not mature creatures, and the name of ichneumon-mites is derived from a theory of Murray's, which cannot, I think, have been the result of observation.

A number of exceptional forms Murray properly gives as "*incertæ sedis.*" He certainly is unwise in separating *Cheyletus* so far from the *Trombidiidæ* and *Bdellidæ* as he does.

Dr. P. Kramer, of Schlensingen, in 1877* published a valuable classification. He divides as follows:

ACARINA.

Acarina tracheata (mites which in the adult condition have *tracheæ* in some stage of development)	Both stigmata close together at the root of the mandibles . . .	PROSTIGMATA.
	Stigmata far apart, situated on the thorax-like front part of the body	ORIBATIDÆ.
	Stigmata, abdominal between the 3rd and 4th pairs of legs, or near the 4th, and provided with a canal in the thickness of the skin directed forward	GAMASIDÆ.
	Stigmata cup-like, situated behind the 4th pair of coxæ . . .	IXODIDÆ.
	Stigmata at the side margin of the 1st of the five abdominal segments	TARSONEMIDÆ.†
	Stigmata wide apart between the two front legs	MYOBIA.
Acarina atracheata (mites which in the adult condition never show any trace of *tracheæ*)	The true ACARI.	
	Glyciphagus.	
	Tyroglyphus.	
	Rhizoglyphus.	
	Dermaleichus.	
	Mycoptes.	
	Listrophorus.	
	Hestiostoma.	
	Phytoptus.	
	Demodex.	
	Sarcoptidæ.	

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parasites du tissu cellulaire chez les oiseaux," Mégnin, 'Robin's Journal de l'anat. et de la physiol.,' 1879, vol. xv, 124.

* "Grundzuge zur Systematik der Milben," 'Archiv für Naturgesch.' 43 Jahrg., Bd. i, 215, 1877.

† *Tarsonemus.* Canestrini e. Fanzago, "Nuovi acari," 'Atti Soc. Ven. Trent. di sci. nat.,' vol. v, 1876, p. 110-141.

Kramer's first family—the *Prostigmata*—includes the *Trombidiidæ*, the *Hydrachnidæ*, the *Bdellidæ*, and the *Cheyletidæ*, taking all these names in their widest sense; but Kramer utterly drops the old main families of *Trombidiidæ*, &c., and hints that *Trombidiidæ* and *Hydrachnidæ* were in fact refuges for destitute mites, and that anything and everything was crammed into them. He divides the whole into fourteen sub-families having equal values, thus: (See p. 45.)

There is also a further subdivision of the *Hydrachnidæ*, &c., into genera.

There is no doubt that this is a most careful classification, and that the *Prostigmata* are a group possessing many things in common and fairly classed together. I incline to think, however, that similarly placed stigmata exist in some other families, although in them these may not be the principal stigmata. I scarcely feel that I can quite follow Kramer in the minor groupings—his division is, I think, so to speak, too refined, and I do not think, on the whole, that the entire breaking up of the well-known divisions of *Trombidiidæ* and *Hydrachnidæ* into small divisions is advantageous. It appears to me that there is considerably more analogy between a *Hydrachna* and many of the other aquatic forms than between it and *Cheyletus*, and that the latter is more closely allied to *Bdella*, &c., and that the different sub-families have not equal natural values; but there is no doubt that Kramer's work is deserving of great commendation.

C. J. Neuman, in 1880, published his book on the Swedish *Hydrachnidæ*;* this does not attempt any general classification of the *Acarina*, but the work is too important, and its mode of dealing with the classification of the family it treats of is too well considered to be neglected. Neuman includes all the old family of *Hydrachnidæ* with the *Hygrobatidæ* in one family—the *Hydrachnides*, his main distinction from other

* "Om Sveriges Hydrachnider," 'Kong Svenska Veten.-Akad. Handl.,' Band. xvii, No. 3. Stockholm, 1880.

PROSTIGMATA.

- **Mandibles, piercing organs**
  - With copulatory suckers in both sexes . . . . . *Hydrachnidæ.*
  - Without copulatory suckers
    - Ultimate and penultimate joints of palpus forming a very long and sharp claw (chela) . . . *Cheyletidæ.*
    - Penultimate joint of palpus forming a moderate claw
      - Piercing hairs of mandibles, strong, doubly bent . *Tetranychidæ.*
      - Piercing hairs, straight . *Rhyncholophidæ.*
- **Mandibles, claw-like**
  - With copulatory suckers in both sexes . . . . . *Hygrobatidæ.*
  - Without copulatory suckers
    - Body-skin shielded, and divided in three plain divisions . . *Raphignothidæ.*
    - Skin soft and not segmented
      - Without eyes . . . . . *Tydidæ.*
      - With eyes
        - Last joint of palpus attached to the base of the penultimate . . . *Trombididæ.*
        - Last joint of palpus attached to end of penultimate
          - Terrestrial, eyes widely separated . . *Erythræidæ.*
          - Aquatic in fresh water, eyes close together
            - All legs without swimming hairs *Limnocaridæ.*
            - Only the 4th pair without swimming hairs *Eylaidæ.*
- **Mandibles, chelate**
  - Penultimate joint of palpus forming a claw; ultimate joint attached sideways . *Megameridæ.*
  - Penultimate joint not forming a claw; ultimate joint attached to the end of penultimate
    - Mandibles short; mouth not snout-shaped . . . . *Pachygnathidæ.*
    - Mandibles long and flat; mouth snout-shaped . . . . *Bdellidæ.*

families is in the possession of two eyes on each side, and his first division is formed by distinguishing those where the two eyes on each side are so close together as to practically coalesce, although preserving a suture which marks their distinctness, from those where the two eyes on each side stand clear from each other. As this is not a book on the *Hydrachnidæ* I must refer the reader to Neuman's monograph for the further details of his classification.

Haller, in his paper on the same subject,* also includes the whole of the creatures which Neuman deals with and the *Limnocaridæ* in one family. The *Hydrachnidæ* or water-mites Haller, however, divides primarily into two families—the *Medioculatæ*, which are the *Limnocaridæ* and the genus *Eylaïs*, and the *Lateroculatæ*,—names which explain themselves.

I now come to my own proposed classification, which I submit as being possibly as good as our present knowledge of the subject will allow. I have not sought to introduce startling novelties, but rather to avoid altering what other naturalists have done unless I thought I saw a decided advantage in doing so, and I have endeavoured to preserve what seemed to me to be the best points in the work of previous classifiers.

I believe that, although distinctness and ease of identification is attained in classifying by a single organ only, yet the result as to the *Acarina* is artificial; the close analogy between groups is the consequence rather of the larger number of important organs of which the arrangement is similar in both; and the larger the number of leading structures, of which the arrangement is the same, or practically the same, the nearer the relationship should be. If a single organ be taken, we shall often find that a difference in it separates creatures widely, which, in the great majority of characteristics, are closely allied; whereas, if the

* 'Die Arten und Gattungen der Schweitzer. Hydrachnidenfauna;' "Die Hydrachniden der Schweiz;" Mittheil. der Bern. Naturf. Gesell., 1881, Heft 2. (Reprinted, Bern, 1882.)

consensus of several organs be chiefly adopted, an exceptional variation in a single organ may be, not disregarded, but considered of less importance than the general agreement. While feeling this view strongly, I readily admit that where a single organ can be found to meet the requirements it is extremely convenient, and I have endeavoured to accept it where it seemed to me to be proper.

It must also be remembered that, although the attainment of a natural classification is in the highest degree desirable, yet, after all, the main object of classification is to enable the biologist to identify the different forms of life which come before him in a reasonably prompt and easy manner. For this reason it seems to me to be objectionable, when dealing with such minute beings as the *Acarina*, to classify by internal organs, or other organs which are extremely difficult to examine. I have therefore endeavoured to keep to the exo-skeleton and such organs as can be inspected, or the existence and position of which can be ascertained, without more difficulty than is necessarily involved in dealing with somewhat complex organisms of the magnitude of those in question: and it must not be forgotten that the exo-skeleton is usually the expression of internal structure.

I have followed Dr. Kramer in his main division into *Tracheata* and *Atracheata*. The respiratory organs are certainly important; and on the whole I do not see any better main division, although I do not like the separation of *Myobia* from *Mycoptes* and *Listrophorus*, and I cannot help thinking that future investigations will remove the distinction; they seem to me very closely allied and not properly to be separated. Otherwise Kramer's division appears to be a natural and a convenient one. It must be remembered that in tracheate groups exceptional forms with the tracheæ rudimentary, or even without tracheæ, may occur.

I have not thought it convenient to adopt the terrestrial and aquatic basis given by so many authors,

because, firstly, in some families, and notably in the *Oribatidæ*, different species, which clearly belong not only to the same family but to the same genus, are some terrestrial and some aquatic. Thus *Oribata sphagni* lives in fresh water, while all other members of the genus with which I am acquainted inhabit dry land. The same may be said of *Notaspis lacustris*. Secondly, some species are terrestrial during one period of their existence and aquatic during another, of which *Hermannia bistriata* is an example. Thirdly, the effect of adopting the land and water basis of primary division is to separate widely the two great groups of *Trombidiidæ* and *Hydrachnidæ*, the close analogy between which has so often been pointed out, and has of late been placed beyond doubt by the careful and elaborate researches of A. Cromberg* into their internal anatomy. Fourthly, although this is a small matter, surely the *Demodicidæ* are more allied to the *Sarcoptidæ* and *Phytoptidæ*, if the latter be mature forms at all, than to the *Hydrachnidæ* or *Limnocaridæ*.

In the subdivision of the *Tracheata* I have practically adopted what Mégnin makes the first means of dividing his terrestrial *Acarina*, namely, general chitinising of the dorsal and ventral surfaces on the one hand, as compared with special sclerites to support the legs and other appendages on the other. This appears to me to be a sound basis, affecting the general form and organisation of the creature in a marked degree, and I think it practically divides the organisms into natural groupings.

For minor subdivisions I have endeavoured to employ the general agreement of several important organs, not finding a single one which would differentiate the sub-orders into what struck me as natural combinations, and I have sought to regard not merely the shape or position of an organ, but also its

* "Über der Bau von Trombidium," 'Bull. de la Soc. de Nat. de Moscou,' 1879, No. 2. "On Eylaïs extendens" (in Russian), 'Bull. Soc. Nat. de Moscou,' 1878, &c.

actual potential qualities and effect on the life of the possessor. The organs of locomotion and respiration, and the trophi, are those which I have chiefly employed.

I have retained the old divisions of the *Trombidiidæ* and the *Hydrachnidæ*, including the *Bdellidæ* in the former, and the *Hygrobatidæ* in the latter.

I think it probable that some day *Mycoptes* and *Listrophorus* may have to be transferred to the *Myobiadæ*.

If *Phytoptus* be really a mature form, it seems to me that its position is where I have placed it; if, on the other hand, it be merely an immature form of *Tetranychus*, as Donnadieu contends, it will drop out of the classification altogether.

I follow Kramer in considering that *Bryobia* is more closely allied to *Tetranychus* than to *Trombidium*, the organisation of the trophi points strongly to this.

I have some doubt about my own correctness in including the *Halicaridæ* among the *Limnocaridæ*, but I think on the whole that they are fairly placed together.

I am fully conscious of many shortcomings in the classification, but, in the imperfect state of our knowledge, and having regard to our great ignorance of tropical forms, I do not feel that, at all events, these defects can at present be removed by myself.

TRACHEATA	Skeleton a rigid sternum attached to a wholly or partly rigid dorsum.	Stigmata ventral; legs of 6 or more joints.	Stigmata protected by a long tubular peritreme in the thickness of the skin; mandibles extensile, chelate; maxillæ styliform (where free). GAMASIDÆ.	First pair of legs usually tactile organs	GAMASINÆ.
				First pair of legs locomotive or holding organs. (All parasites of, or feeding on, vertebrata)	PTEROPTINÆ, including DERMANYSSUS.
			Stigmata protected by a cullender-like plate; mandibles serrated, but without any moveable joint; maxillæ wholly anchylosed, forming a serrated rostrum		IXODIDÆ, including ARGAS.
		Principal stigmata, when present, in acetabula of the legs. Two conspicuous dorsal tubular pseudo-stigmata, each having an organ (or hair) projecting from inside the tube. Legs of five joints, all legs solely locomotive organs. Maxillæ flattened, crushing organs; mandibles chelate.			ORIBATIDÆ.
	Skeleton composed of sclerites embedded in a soft skin.	Palpi raptorial, or holding organs. Stigmata near the rostrum. PROSTIGMATA.	Legs of 6 or more joints, all legs cursorial organs. TROMBIDIIDÆ.	Palpi chelate	TETRANYCHI, including BRYOBIA.
				Palpi raptorial	TROMBIDIINÆ.
				Palpi antenniform	BDELLINÆ.
			Legs of 5 joints, first pair tactile organs		CHEYLETIDÆ.
			Legs of 6 or more joints, swimming organs; two eyes on each side, usually far apart		HYDRACHNIDÆ.
			Legs of 6 or more joints, crawling organs. Habits of life wholly or partly aquatic		LIMNOCARIDÆ, including the HALICARINÆ.
		Palpi almost obsolete. Legs of 5 joints			MYOBIIDÆ.
ATRACHEATA	With all 8 legs developed.	Legs of 5 joints; chelate mandibles. Skeleton composed of sclerites in a soft skin. ACARI proper.	Non-parasitic, with 2 front pairs of legs set below the body		TYROGLYPHIDÆ.
			Parasitic. Front pairs of legs set on the anterior margin of the body. SARCOPTIDÆ.	Living on the feathers of birds or the hairs of mammals	ANALGINÆ (*sive* DEMALEICHINÆ), including MYCOPTES and LISTROPHORUS.
				Subcutaneous	SARCOPTINÆ.
		Legs of 3 joints.	Without caudal prolongations		ARCTISCONIDÆ.
			With caudal prolongations		DEMODICIDÆ.
	Two hind pairs of legs abortive				PHYTOPTIDÆ.

CHAPTER V.

THE CLASSIFICATION OF THE ORIBATIDÆ.

AFTER elucidating the position of the family of *Oribatidæ* it is necessary to enter upon the minor classification of that group into sub-families and genera. Before entering upon the arrangement which I propose to adopt I will refer to what others have done in the same field.

The first work which need be noticed is that above-named, by C. L. Koch, of Regensburg;* this author did not make any divisions wider than genera, but he established thirteen genera, one of these, *Oribata*, being a restriction of the name which Latreille gave to the whole family; the other twelve being entirely new.

These thirteen genera were: 1. *Oribata*. 2. *Zetes*. 3. *Eremæus*. 4. *Pelops*. 5. *Cepheus*. 6. *Oppia*. 7. *Damæus*. 8. *Carabodes*. 9. *Celæno*. 10. *Hypochthonius*. 11. *Nothrus*. 12. *Murcia*. 13. *Hoplophora*.

The first remark to be made as to these is that the genera *Celæno* and *Murcia* consist entirely of immature creatures, are founded solely on nymphal types, and may therefore be dismissed from consideration. This leaves eleven genera; it has been supposed that *Hypochthonius* was also constituted of immature forms, but my experience is rather to the contrary effect. Amongst these eleven it is far from easy to understand what distinction Koch drew in his own mind between *Oppia* and *Damæus*. In the next place, several of his genera, more especially *Oribata* and *Nothrus*, are groups of creatures

* 'Uebersicht des Arachnidensystems;' Nürnberg, 1842, *et seq.*

differing so widely from each other that it is difficult to understand what was the principle upon which they were respectively included in one genus and separated from the species composing *Carabodes*, *Eremæus*, &c. Unfortunately, Koch's definitions of his genera do not go far in assisting our endeavours in this respect. They are somewhat long, but do not usually express any distinct means by which subsequent observers can decide to which of the genera a new form should be allotted. In the instance of *Oribata* and *Zetes*, where he states the distinction clearly enough, it scarcely seems to be sufficient, it is the absence in the latter genus of apophyses on the vertex ("*Stirnzapfen*"). I do not think that I should be assisting the reader by translating all Koch's definitions of his genera, which I confess I cannot myself grasp in most instances; some portions, as "eyes not visible, rostrum hidden," &c., are repeated in each genus, so that apparently they might as well be in the definition of the family, which, by-the-bye, is eyeless. In spite of these remarks some of the genera, as *Pelops*, *Hoplophora*, and *Damæus* with *Oppia*, if these last-named two of Koch's genera be taken as forming one, are natural groups, although they may not be well defined, and there is not any difficulty in saying what ought to belong to them. These genera stand as Koch originated them, although they have been better defined; and they will probably continue to hold their ground. It will be seen that most of Koch's other names for genera composed of adult forms have been retained, although his definitions of them may have been abandoned.

The next effort was that of Nicolet, in his work before referred to;* and this may fairly be considered the existing classification. It is perfectly clear what Nicolet's ideas were, and how he intended to define his genera. The following is a translation of his classification, viz.:

* "Histoire naturelle des Acariens qui se trouvent aux environs de Paris," 'Archives du Muséum,' t. 7, Paris, 1855.

FAMILY OF THE ORIBATIDÆ.

Claws tridactyle.	Cephalothorax with lamellar appendages.	With lateral aliform expansions (to the abdomen) and heterodactyle claws.	Interstigmatic hairs spatulate		PELOPS.
			Interstigmatic hairs setiform		ORIBATA.
		Without lateral aliform expansions.	Claws homodactyle.	Tectum attached to the cephalothorax only by its base	CEPHEUS.
				Tectum coalescent with the cephalothorax, its wings only being visible	NOTASPIS.
			Claws heterodactyle		LEIOSOMA.
	Cephalothorax without lamellar appendages.	Legs slender, with flexible hairs and fusiform joints, terminated by a heterodactyle claw			EREMÆUS.
		Legs thick, with stiff hairs and sub-cylindrical joints, terminated by a homodactyle claw			NOTHRUS.
Claws monodactyle.	Cephalothorax with projecting apophyses or nervures.	Legs longer than the body			DAMÆUS.
		Legs shorter than the body			TEGEOCRANUS.
	Cephalothorax without apophyses.	Cephalothorax anchylosed to the abdomen and immoveable			HERMANNIA.
		Cephalothorax articulated with the abdomen and moveable			HOPLOPHORA.

Andrew Murray* says of this classification, "The more important characters used in sub-dividing the species of this group are drawn from the number of claws to the tarsi, and certain peculiar plates or expansions which are borne by the cephalothorax and abdomen. These, however, only serve the purpose of an artificial arrangement, and we have disregarded them in our attempt at a more natural classification." Unfortunately, however, Murray's "more natural classification" is not forthcoming; he certainly puts the genera in a different order, viz. *Damæus*, *Leiosoma*, *Notaspis*, *Oribata*, *Pelops*, *Nothrus*, *Hermannia*, *Cepheus*, *Eremæus*, *Hoplophora*, but he defines each of his genera precisely in Nicolet's words, and uses Nicolet's genera exactly, except that he omits *Tegeocranus*. This Murray seems to have forgotten, as he does not say that he has omitted it intentionally, nor does he suggest where the creatures composing it should come. I cannot see that his change in the order of the genera is an improvement. Had Murray made a more serious effort to construct a natural classification he might possibly not have found it very easy. It will be seen that I am not able quite to follow Nicolet in his classification, but this is greatly on account of species found by me, which were not known to Nicolet, and which render it difficult to retain his definitions; but I confess that I abandon his classification with great regret, as, although somewhat artificial, I consider that it was, on the whole, a very good one, having regard only to the species known to him.

In 1877 Professors Canestrini and Fanzago, of Padua, published their work on Italian *Acarina*,† and this contains the following classification of the *Oribatidæ*, possibly only intended to apply to the Italian species.

* 'Economic Entomology,' Aptera, 213, 1877.

† "Intorno agli acari Italiani," 'Atti del R. Ist. Veneto di Sci., &c., ser. v, vol. iv, 1877.

Family ORIBATINI.

I. With lateral lamellar expansions attached upon, or at the sides of, the cephalothorax.

A. With two mobile wings to the abdomen.

1. *Pelops.*—Interstigmatic hairs spatulate, placed below a quadrangular lamellar prolongation of the abdomen.
2. *Oribates.*—Interstigmatic hairs setiform.

B. Without wings to the abdomen.

3. *Leiosoma.*—Body oval. Palpi usually short, not projecting beyond the anterior margin of the cephalothorax. Tectum normal. Mandibles quadridentate.
4. *Cepheus.*—Body broad, somewhat depressed. Palpi short and filiform. Tectum enlarged, forming a sort of shield above the head. Mandibles quadridentate.
5. *Oppia.*—Body sub-globose. Palpi long, projecting beyond the anterior margin of the cephalothorax. Tectum normal. Mandibles tridentate.

II. Without lateral expansions to the cephalothorax.

A. Tarsi tridactyle.

6. *Eremæus.*—Mandibles tridentate. Central claw of tarsus larger than lateral ones. Legs with one or more long flexible hairs. Body roundish.
7. *Nothrus.*—Mandibles quadri- or quinquedentate. Claws homodactyle. Legs with the hairs pointed or clavate, of a uniform size. Body usually angular.

A. Tarsi monodactyle.

8. *Belba.*—Cephalothorax with ear-like appendages. Mandibles tridentate. Legs long and nodose.

9. *Hoplophora.*—Without ear-like appendages. Mandibles multidentate. Legs of usual form and length. Cephalothorax covered by a uniform shield and moveable on the abdomen.

The extent to which I follow, and the points in which I am not prepared to follow, the able and experienced Italian professors will best appear from my remarks (immediately following this paragraph) upon my proposed classification, in submitting which I wish it to be clearly understood that it is only intended to apply to British species, and to such British species as are known to me. My reason for this not very desirable course is, that I do not consider that the foreign forms are sufficiently well known to make it possible to classify them properly, and even as to British forms I cannot expect by my sole labours, confined to the not very ample leisure of a few years, to have exhausted the species; nor can I foresee what changes future discoveries may necessitate. While I make this statement, however, it must not be supposed that I have wilfully neglected existing sources of knowledge; I believe that the classification proposed below will be found applicable to all recorded species, both British and foreign, *as far as can be judged by the records;* but these records, doubtless, do not include a large proportion of the species, and the records, being mainly by Koch, are so imperfectly written that certainty is not to be obtained from them. It is highly probable that, if one could examine all the recorded species in life, it would be discovered that other groups might have to be formed in addition to those of the classification, or that some of the proposed distinctions would have to be modified.

In endeavouring to systematise the family I have felt compelled to abandon Nicolet's primary division into tridactyle and monodactyle. It will be seen that Canestrini has done so before me; but apparently his

reasons must have been different. I confess that I abandon it with regret, because, although artificial, it is eminently convenient, and would afford a ready means of commencing identification, if it could only be relied on. I think that if I had only been acquainted with the species which Nicolet knew of, I should have been tempted to adopt it; but, amongst the new species which I have found, are two which present every possible character of the genus *Oribata* in the most perfect manner, except that they are monodactyle. I do not think that any careful biologist would class them otherwise than in this genus, but if so classified what becomes of the primary division, for *Oribata* is the very type of the tridactyle genera; and if there be two such species there may probably be more. Again, one of the aquatic species which I have found bears every characteristic of the genus *Notaspis*, a tridactyle genus, but this species has one claw only; but if there might be any doubt about this *Notaspis* not being a genus so clearly defined by nature, there cannot be any doubt about *Oribata*, which is certainly a natural group. I have, therefore, ventured to call these species respectively, *Oribata fusigera*, *O. parmeliæ*, and *Notaspis lacustris*, and to give up Nicolet's primary division. Berlese* draws at least one *Damæus* (*Dugesii*) with tridactyle claws; he proposes to call those with one claw *Belba*, and with three claws *Damæus*: he gives three of the latter. In a later number (April, 1883) the same author describes and figures a creature which he identifies (I am not sure why) with *Hoplophora decumana*, Koch, and for which he makes a new genus, *Tritia*; its only difference from *Hoplophora* is in the possession of tridactyle claws, and a certain difference in the form of the genital and anal plates. I scarcely think it desirable to found a genus on these distinctions.

Having parted with Nicolet's division it is necessary

* 'Acari, Miriapodi e Scorpioni Italiani,' fas. 3, tav. 6. Padua, 1883. 'Sopra due nuovi generi di acari Italiani.' Let. alla R. Accad. di Padova, August, 1883.

to replace it, and I may be excused in doing so for referring again to what a classification is meant for. A classification should assuredly be a natural one if possible, but its primary use is to enable those who have a species to identify it; if it fail in this it does not attain its end, therefore I have in this, as in the general classification of *Acarina*, refrained from relying on the internal organs; believing, as before stated, that, in order to be useful, a classification of these minute and opaque creatures must be based upon the external structure. Regarded from this point of view, there seems to me one striking characteristic dividing the *Oribatidæ* into two well-marked sub-families, which are both natural and clear, although, unfortunately, one sub-family is much larger than the other. I allude to the presence or absence of the wing-like, chitinous expansions of the abdomen, which form so remarkable a characteristic of a large number of species, and which greatly affect the organisation and habits of the animal. I have utilised this distinction, and propose to call those with the wing-like expansions PTEROGASTERINÆ and those without APTEROGASTERINÆ (*Gymnogaster* and *Psilogaster* being already appropriated).

The *Pterogasterinæ* contain two genera only, namely, *Pelops* and *Oribata*; but then the latter is far the largest genus in the family. The ordinary distinction between these two genera, given by Nicolet in his classification, is, that what he calls the interstigmatic hairs—my interlamellar hairs—are spatulate in *Pelops*, whereas they are setiform in *Oribata*; to this Canestrini adds that they proceed from beneath a square chitinous projection of the anterior margin of the abdomen, which, of course, is noticed by Nicolet, but not in his classification. This square projection is a thin, chitinous, horizontal piece, and is sufficiently curious; the interlamellar hairs are very largely developed, and their complete spatulate shape and horizontal position are remarkable; still they seem to me scarcely a satisfactory distinction. The real distinction of *Pelops*,

not only from *Oribata* but also from all the other genera in the family appears to me to lie in the form of the mandibles, which, instead of being broad and large from base to chela, and ending in powerful chelæ worked by vigorous muscles within the mandible, as they are in all other genera, are suddenly effiliated after about a third or a quarter of their length, and continue to the end mere rods terminated by very minute chelæ. The object of this is evidently to enable them to be thrust into very minute holes, and it is doubtless connected with the habits of life, and is an important modification. I have utilised it as the principal distinction. It is also to be remarked in favour of doing so that the creature which I call the *Pelops phænotus* of Koch has the general appearance, and all the minor characteristics, of the genus, but has not largely developed, spatulate, interlamellar hairs, nor the square chitinous projection, but it has the characteristic mandible. Whether it be the same creature as that so named by Canestrini may be doubtful; this point is more fully entered into in treating of this species, but whatever be the name of the English form the facts are the same.

In dealing with the *Apterogasterinæ* there is one genus, *Hoplophora*, so entirely different from the rest, that, although it is not a very large genus, I think the next division is fairly between that and the rest. The crucial point of differentiation is that in *Hoplophora* the cephalothorax is articulated to the abdomen by a ginglymus joint, instead of being anchylosed; enabling the acarid to shut itself up like a ball and enclose the legs; moreover, the ventral plate is not anchylosed to the dorsal, as in all other genera. I have made this the second subdivision, I think it is a natural one; but, having utilised it, further good natural divisions become scarce, and it is necessary to do, not exactly what one would, but what one can. The genus *Nothrus* is probably the only well-marked natural group left, for, although the extreme forms of *Damæus* are very striking,

yet they fade into *Notaspis* and other genera without sharp natural lines of demarcation.

The next distinction which I have employed is the possession or absence of lamellæ on the cephalothorax. I have been forced to abandon Nicolet's tectum, because, as will be seen in the chapter on the anatomy of the ex-skeleton, I find by dissection that there is not such an organ, the lamellæ being all that really exist (see Chapter 9, where these parts are described).

Amongst the genera having lamellæ *Notaspis* is marked by having the last three pairs of legs inserted close to the edge of the body instead of underneath it; a somewhat important distinction, which I utilise more readily because I feel compelled to abandon Nicolet's distinction of homodactyle and heterodactyle claws. It is quite true that in some genera the central unguis is much more conspicuously different from the lateral ones than it is in other genera, but I doubt if a true homodactyle claw, *i.e.* one with all three ungues exactly alike, exists among the English *Oribatidæ*, the central unguis appears to me always to differ more or less from the others.

Among the genera with lamellæ and legs set under the body, one genus, *Tegeocranus*, has all the species known to me with monodactyle claws, the other genera have all their species known to me tridactyle, and I have used this, not without misgivings as to what species may be found hereafter.

Among the group without lamellæ *Nothrus* and *Hypocthonius* are at once differentiated by their somewhat leathery or imperfectly chitinised cuticle, the more or less rectangular shape of the abdomen, and their flat or hollow notogaster.

Among the tridactyle genera there is one (*Serrarius*) which has serrated, non-chelate instead of chelate, mandibles, an important structural difference forming a good basis of division. This leaves three genera with chelate mandibles; two of these have the cephalo-

thorax sharply divided from the abdomen by an unbroken line; in the third genus, viz. *Scutovertex*, a projection from the abdomen extends over the cephalothorax, not standing free as in *Pelops*, but anchylosed to it, so that it is not easy to fix on the precise dividing line. The two genera with the unbroken dividing line are Koch's *Cepheus* and Nicolet's *Leiosoma*. The difference which the latter author makes between them is that *Cepheus* has homodactyle claws and *Leiosoma* heterodactyle; but, in the first place, as before stated, I doubt whether there are any truly homodactyle claws in the family, although *Cepheus tegeocranus* comes very near to it; and, next, the claws of *Cepheus bifidatus*, which is in other respects similar to the typical species of the genus, are as heterodactyle as those of a *Leiosoma*. Nicolet also says that the tectum of *Cepheus* is attached by its posterior edge only; but, as explained above, the tectum does not exist: thus, both distinctions having broken down, is there any advantage in preserving the genus *Leiosoma?* Were I commencing the classification I should not have originated it, but the creatures included in it have not hitherto been comprised in *Cepheus*, and their appearance is very different, although I do not find any great structural distinction.

The name *Leiosoma* (Kirby) had been used in Stephens' catalogue in 1831, and by Cheviolat in 1837, for genera of *Coleoptera*, therefore, had Nicolet been English, there would be an inclination to drop his name, but one hesitates to consider him bound by British Association rules which he probably did not recognise. Were I to abandon the name *Leiosoma*, I should not be inclined to originate another, but should leave the group as a subdivision of *Cepheus*. As, however, the creatures are known as *Leiosoma* all over Europe, I have, on the whole, thought it best to leave the name of *Leiosoma*, giving *Cepheus* as a substitute, and allow my readers to use which they think best. The only tangible distinctions which I can find are, that in *Leiosoma* the

lamellæ are small and the abdomen smooth, while in *Cepheus* the lamellæ are conspicuously large, and lighter in colour than the rest of the body, and the abdomen is rough. Many of the singular immature forms of these two genera have a remarkable resemblance, which is another reason for doubting whether they should be separated.

Amongst the remaining genera the tridactyle or monodactyle claws again become available, subject to the same remark as before, the genus *Eremæus* being the only tridactyle one.

There remain two genera; of these *Hermannia* is very readily distinguished from *Damæus* by the thick legs with cylindrical joints, instead of the thin legs with clavate or moniliform joints possessed by *Damæus*.

Some of the species composing the genus *Damæus* have almost globular abdomens, in some they are longer and more pointed; in some the legs are extremely long, mostly, but not entirely, in the round-bodied species; in some they are only moderately long; in some species the joints are clavate, in others moniliform. I had thought of utilising these distinctions to subdivide this rather large genus, and had intended doing so by reviving and defining Koch's genus *Oppia* (his distinction of which from *Damæus* I cannot understand), but on careful examination I found that the differences arose so gradually in the different species, and it would have been so difficult to draw the line, that I gave up the idea, for, if it were difficult to draw, it would be unsatisfactory when drawn.

With the above remarks I submit the classification at the end of this chapter; in it I have endeavoured to give the principal distinctions, and to preserve as fairly natural a linear arrangement as I can; but it is an old story, that, although linear arrangements are necessary for our books, nature does not lend herself to them; the characteristics of allied living forms are like the ripples produced by a number of stones

dropped into water, each extends in a circular direction, and they constantly cross and recross. Thus *Tegeocranus* and *Hermannia* might well have come together, but it was more important to keep *Notaspis* and *Damæus* together, as some of their species are even more closely allied than those of the former two genera; again, the projecting corners of the abdomen in *Notaspis* seem like slight remains of the wing-like processes of the *Pterogasterinæ*, but in most other characteristics the genus is more like *Damæus*.

Finally, *Pelops* is put first and *Hoplophora* last by Nicolet, and, as I do not see that I can improve this, I adhere to it.

ORIBATIDÆ.

- Abdomen with chitinous, wing-like expansions. PTEROGASTERINÆ.
  - Mandibles broad at base, suddenly becoming and continuing very slender and rod-like; chelæ small; interlamellar hairs usually spatulate . . . . PELOPS.
  - Mandibles thick and stout, not slender nor rod-like in any part; interlamellar hairs usually setiform . . . . ORIBATA.
- Abdomen without chitinous, wing-like expansions. APTEROGASTERINÆ.
  - Cephalothorax anchylosed to abdomen. Ventral plate anchylosed to dorsal.
    - With lamellæ.
      - Last 3 pairs of legs inserted under the body.
        - Claws tridactyle.
          - Mandibles serrated and not chelate . . . SERRARIUS.
          - Mandibles chelate.
            - Cephalo-thorax and abdomen separated by an unbroken line.
              - Lamellæ small, abdomen smooth . LEIOSOMA.
              - Lamellæ very large and light colored, abdomen rough . CEPHEUS.
            - Cephalthorax and abdomen joined by a central projection . . . . SCUTOVERTEX.
        - Claws monodactyle . . . . TEGEOCRANUS.
      - Last 3 pairs of legs inserted at the edge of the body . . . . . NOTASPIS.
    - Without lamellæ.
      - Abdomen round or oval; notogaster arched; cuticle of adult fully chitinised.
        - Claws monodactyle.
          - Legs thin, with clavate or moniliform joints . . . . DAMÆUS.
          - Legs thick, with cylindrical joints . . . . . HERMANNIA.
        - Claws tridactyle . . . . EREMÆUS.
      - Abdomen square, oblong, or rhomboid; notogaster flat or hollow, or with a raised margin; cuticle of adult imperfectly chitinised.
        - Claws tridactyle; abdomen without lateral blades . . . NOTHRUS.
        - Claws monodactyle; abdomen with lateral blades . . . HYPOCTHONIUS.
  - Cephalothorax hinged to abdomen, and folding down on its ventral surface. Ventral plate not anchylosed to dorsal . . . . HOPLOPHORA.

CHAPTER VI.

DEVELOPMENT AND IMMATURE STAGES.

The development of one of the *Oribatidæ*, as indeed of *Acarina* in general, may be divided into three main stages; namely, the egg, the larva, and the nymph; the next change after the nymphal period brings the creature to its mature or imaginal condition, and development may be said to have ceased. Two of these stages, *viz.* those of egg and nymph, may properly be subdivided; the egg most properly into three periods, *viz.* 1, development within the body of the living mother; 2, development after oviposition or after the death of the mother (both of these being usually in what may be called the primary period); and 3, the deutovium period. These three periods do not, however, occur in every instance. The nymphal state may be subdivided into two periods, *viz.* the active and the inert.

It is necessary to define what is the signification of the respective terms used above, as considerable confusion has arisen from different authors using them in various senses, so that, as pointed out in Chapter II, the term does not always give to the mind a definite idea which is applicable to the writings of all biologists who have treated of the subject, unless a definition be supplied.

The egg is luckily a term with regard to which no divergence, that I am aware of, exists. An ovum is a well-understood expression, as to which difference of opinion cannot easily arise. The meaning attached to the phrase "deutovium stage" will be best gathered from the description given below.

The expression "larva" or "larval stage" is used in this book to signify the creature after it has emerged from the egg, and while it is still hexapod; a stage which, as far as my knowledge goes, exists in all *Acarina* except probably *Pteroptus*, *Demodex*, and *Phytoptus*, if, indeed, the last be really mature creatures; and, in the last two exceptional genera the absence of the normal number of legs may probably be regarded as arrested development or abortion from disuse. *Pteroptus* is asserted to have larvæ octopod at birth. I have not any experience on this point, and only give the statement on the authority of others; if it be correct, probably the larval stage is passed within the egg. This is a well-marked period in the *Oribatidæ*, but is distinguished by Nicolet as the "young larva." Henkin calls it "Schadonophan" (in *Trombidium*)* while still within the deutovial egg-membrane.

The expression "nymph" or "nymphal stage" is used, in this book, to signify the creature after it has become octopod (or has attained its full ultimate number of legs in the case of exceptional genera as above mentioned) and prior to the last ecdysis. This stage is called the "larval" by Nicolet and many others; I have, however, in this matter followed the very convenient nomenclature of Dugès and others, who call this stage the "nymphal" in consequence of the analogy to that so named in the life-history of *Orthoptera*, &c., which lead an active existence during what would in *Lepidoptera* be the pupal condition.

It will be seen from the above, and from the following pages, that the *Oribatidæ* have not complete transformations, in the technical sense applied to that expression by those authors who consider transformations to be incomplete unless they include an absolutely inert pupal stage, during which the animal does not

* "Beiträge zur Anatomie, Entwicklungsgeschichte und Biologie von Trombidium fuliginosum," 'Zeit. für wiss. Zool.,' Bd. xxxvii, 1883, p. 596.

feed, and during which it is different from its appearance at any other period. The *Oribatidæ*, however, undergo transformations sufficiently marked to render them totally different at one period of their life-history from what they are at another, so that, in the majority of cases, it would be impossible to identify the nymph with the adult except from knowledge; indeed, C. L. Koch and other authors have supposed all the nymphs to be separate species, and have so named, described, and figured all they found.

An idea exists amongst naturalists that the *Oribatidæ* are viviparous; this error, for an error it certainly is in the main, although possibly with some rather exceptional grounds for it, has crept into the very highest places; for instance, it is stated as a fact in Huxley's 'Anatomy of the Invertebrata,'* and in Rymer Jones's 'Animal Kingdom.'† As far as I can ascertain the idea originated with Dujardin, who is responsible for this, and I fear for other not less important errors connected with the family.‡

Claparède, in his chapter on the development of *Hoplophora contractilis*, as he calls it, which is his only work upon *any of the Oribatidæ*,§ expressly says that, although the general idea is that they are viviparous, the belief is erroneous. Nicolet ‖ says that the egg is deposited and that the larva ("young larva" as he calls it) emerges very shortly after; this is unquestionably true in a great number, probably in the majority, of instances; but, as will be seen below, my own opinion is that no single rule will hold good for all species and all seasons of the year.

Before commencing such details as I am able to offer respecting the life-histories of the *Oribatidæ*, it will, I think, be best that I should inform the reader

* London, 1877, p. 383.
† 4th edition, 1871, p. 399.
‡ "Premier Mémoire sur les Acariens," 'Ann. Sci. Nat.,' 3me sér., t. 3, p. 5 (1845).
§ Op. cit.
‖ Op. cit.

exactly how these facts, so far as they rely upon my personal observations, or have been verified by me, were ascertained; so that he may judge for himself whether or not they are reliable. The few remarks found in this volume relative to the development of the egg within the body of the mother and previous to hatching have been founded solely upon actual dissection.

The progress of the deutovium stage after the deposition of the ovum has been observed by keeping one or two known eggs in each instance in one of the glass cells mentioned below, and placing them under the microscope for observation at frequent intervals. The escape of the larva from the egg is described from watching it take place actually on the stage of my microscope again and again. When an egg in one of my cells has commenced to hatch, either the cell or the egg, generally the whole apparatus, has been transferred to the microscope, and the process watched until complete.

The whole of the observations upon larvæ and nymphs, and the whole tracing of life-histories as well as the greater part of the observation upon the eggs, have been done as follows:—I have used a number of glass cells, each composed of an ordinary microscopical glass slip 3×1 in., having in the centre, fastened by marine glue or Canada balsam, a glass ring made of a transverse slice of glass tubing about $\frac{3}{4}$ths or $\frac{7}{8}$ths inch in diameter, the length of the tube, and consequently the depth of the cells, being usually about $\frac{3}{8}$ths inch. The tubing I employ is of tolerably thin glass, if very thick it is opaque, and leaves little room inside the cell. Over this a thin glass cover, rather larger than the diameter of the tubing, was laid, either a circle or square; the latter is often handy, as the projecting corners are convenient to take it on and off by, or sometimes a second slide or a broken piece of one is more serviceable. This cover was always quite loose, and simply held on by an ordinary brass-wire micro-

scopical spring-clip; of course the upper edge of the slice of glass tube required to be smooth, so that the cover would lie flat upon it, and not allow the minute prisoners to escape.

A cell so prepared was carefully cleaned out, and examined under the microscope, to see that it did not contain *Acarina* or ova. A small piece of thick white blotting-paper, not large enough to cover the whole bottom of the cell, was then placed in it and damped; a piece or two of growing moss or fungus was then placed in the cell, having first been carefully examined under the microscope to see that it also was free from *Acarina* and ova, and the cell was then ready for use. One or two specimens of the larva, nymph, or species to be observed, were placed in the cell, never so many but what I knew each individual specimen; the cover was put on, fixed with the clip; a label with a statement of what was inside affixed to the slip, and the whole put away in the dark or in very dull light. By carefully attending to the hygrometric condition of the cell, damping the blotting-paper, or removing the cover to give air as required, I found that most species throve well in this manner, and got quite accustomed to the cells, not trying much to escape; I have often had a cell uncovered for a considerable time without losing the inmates, although the creatures can climb up glass. The moss kept green for a long time, and minute fungoid growths often arose and afforded appropriate food to some species, but this fungus is apt to grow too vigorously and smother everything. Another good mode of providing the fungus-eating species with food I found to be by putting a minute piece of mouldy cheese in the cell, this soon bore a fine crop which was highly appreciated; of course the cheese should be examined to see that it does not contain *Tyroglyphi* or ova, although these can be distinguished from *Oribatidæ* if one should get in. I have often kept as many as fifty of these cells going at one time, each with its special inhabitants. The attention they

required to preserve the hygrometric and other necessary conditions was considerable, and it is due to my wife's patient care that I was enabled to continue these studies. When it was desired to observe the inmates, which was done at frequent intervals, the clip was removed and the cell transferred to the stage of the microscope. If low powers were sufficient, the cover did not require to be removed if kept clean and if free from condensed moisture; if, however, I wished to use higher powers, I found that I could usually safely remove the cover; of course it often happened that a creature which I wished to watch was in a part of the cell where the objective would not go, in the case of high powers (by which I do not mean really high powers but such powers as $\frac{1}{4}$th or $\frac{1}{6}$th), and then the animal had to be moved, which I found could generally be safely done with a camel-hair pencil. In this way I could watch individual known specimens, with a certainty that I always had the same specimen under observation, not one at one time and something else supposed to be the same species but really different at another. Whenever I found anything specially interesting going on I watched until it was over if I had the time at my disposal.

I found these simple cells answer better than any of the more elaborate apparatus. In particular I tried Mr. Macintyre's ingenious cork cells, by the aid of which he did such excellent work in rearing small insects, but I did not find them answer for *Oribatidæ*. In the first place, many species, being wood-borers, simply eat their way out or into the cork; in the next place, my very minute pets got lost in the interspaces of the cork and never reappeared; in the third place, the cells got dry too easily, and were apt to be too wet or too dry; the former of which was injurious, and the latter always fatal.

THE OVUM.

The eggs of *Oribatidæ* are almost always elliptical, or cylindrical with rounded ends; sometimes they are flattened a little on one side, and occasionally they are slightly curved longitudinally, so as to have a tendency to a crescent shape, but still with rounded ends. They are generally of a membranous texture, sometimes with a granular, frosted-looking skin (as in *Nothrus theleproctus*, &c.). Sometimes these granulations are produced so as to form a thickly-set protection of projecting processes all over the surface of the egg, as in *Oribata punctata* (Pl. G, fig. 6). Sometimes the membranous surface is more polished, as in *Notaspis lucorum* and *Notaspis bipilis:* the membranous eggs are usually white or milky at first, and become yellower or light-brown afterwards. A totally different type of egg, as regards texture and colour, exists, *viz.* such eggs as those of *Damæus geniculatus* and *D. clavipes*, *Leiosoma* (*Cepheus*) *palmicinctum*, &c., which become covered with a hard chitinised shell, which is dark brown or almost black in *L.* (*Cepheus*) *palmicinctum*, brittle and non-expansive, but perforated with numerous excessively minute holes.

I regret to say that the limited time at my disposal has not allowed me to make any observations on the embryology of sufficient importance to record here, and therefore omit that subject, hoping to deal with it at a future period.

It appears to me that there are at least three, if not four, modes in which the later development of the egg and the escape of the larva are provided for. Firstly, the egg is laid as usual among insects, the long ovipositor of the female being used for this purpose, and depositing the egg in crevices of the wood, moss, or fungus, upon which the larva will feed; the egg being deposited when mature as an egg, but before the formation of the larva has commenced, or before it

has advanced very far; this I have frequently observed with *Damæus geniculatus*, *D. clavipes*, *Nothrus theleproctus*, *Pelops acromios*, &c. A considerable time often elapses with these species between oviposition and the escape of the larva.

The second mode is that the development of the larva is almost completed within the body of the living mother, and that the egg is deposited, as in the former case, but the larva emerges very shortly afterwards; this is the mode which Nicolet considers, or apparently considers, to be universal; my experience is that it is not so, although very frequent.

I suspect strongly that a third mode is that the mother is ovo-viviparous. I cannot say that I have ever witnessed the birth of a living larva not enveloped by an egg-shell or membrane from a living mother, but in the case of *Scutovertex maculatus* I have dissected out of a mother, living, or killed for the purpose of, and immediately before, the dissection, larvæ, which, if not able to run about, were fully formed, able to kick their legs, work their mouth-organs actively, and otherwise exhibit signs of life. Moreover, I have several times found larvæ in a cell where I had kept a pair of adults, male and female, or what I believed to be such (for they are often extremely difficult or even impossible to tell without destroying them), although I had carefully examined the cell shortly before without detecting any signs of ova. I am aware that all this is not actual proof, but it seems to me to raise a very strong presumption.

In these methods usually only one or two eggs are ripe at one time, but I have seen as many as eight or nine which have attained the full size.

The fourth mode, which has not, I believe, been observed by any one before myself, I have remarked several times in *Oribata globula*; it is that the female develops several ripe eggs at the same time, until, indeed, the abdomen appears to become entirely filled with the eggs. These eggs are not laid, nor do they

hatch within the body of the living parent, but the mother dies, and all internal parts of the abdomen, except the eggs, dry up and almost disappear: thus the shell of the parental body remains as a protection to the eggs until they hatch. When in due course, or under the influence of warmth, this takes place the young larvæ escape by the genital or the anal aperture: this is usually facilitated by the dropping off of the folding doors (genital and anal plates) which close these respective apertures during life. Sometimes the apertures are hardly large enough to allow of the passage of the larvæ, which then have great difficulty in escaping. I have assisted some of those which I have bred in confinement.

I am inclined to believe that this fourth method is more frequent at the approach of winter than at other times, and that the eggs thus protected pass the winter in comparative security, and are hatched on the approach of warmth and spring.

Dr. G. Haller, of Bern,* found numerous dried shells (or abdominal portions of exo-skeletons) of *Hoplophora* in winter among fallen leaves, each carcass had a mature egg in it, and Haller concludes that the female *Hoplophora*, when about to deposit its eggs, seeks for the cast skins of members of its species, and deposits one egg in each for protection; this of course may be so, but, in the absence of further information on the subject, I should fancy that it is more likely to be an instance of the fourth method above described, except that, in this instance, only one egg is ripe at the time of the death of the parent.

The curious stage called by Claparède the "deutovium" has been well observed and described by that writer in the case of *Atax Bonzi*,† but I am not aware that anyone before myself has noticed it in the *Oribatidæ*; it exists, however, in the case of *Damæus*

* "Miscellanea acarinologica," 'Mittheil. der Schweitzen Entom. Gesellschaft,' 1879, No. 4, 502.

† "Studien der Acariden," 'Zeit. für wiss. Zool.,' 1868, p. 452.

geniculatus, *D. clavipes*, &c. In these species the exterior membrane, or shell, of the egg, although soft and almost white at first within the oviduct, becomes brown, hard, and brittle, in fact, chitinous, usually before deposition, the chitin being of course pierced by numerous punctures. As the contents of the egg expand and the embryo develops, this hard, unyielding envelope becomes too small for the contents, and a split commences, which gradually extends longitudinally right round the periphery, passing through or near to the poles of the egg, and thus dividing the outer shell into two equal, or sub-equal, somewhat boat-shaped halves. The split only penetrates the outer shell, and allows the inner, or vitelline, membrane to be seen through the opening; this membrane is thin, flexible, elastic, and pale-yellowish or white. At first a thin line only shows, but, as the embryo increases in size, it become a broad band, having the halves of the original outer shell on each side. Under a low power this split, with the paler membrane showing through, may easily be mistaken for a light stripe round the egg.

The deutovium stage sometimes occurs within the body of the parent (Pl. G, fig. 1).

When the embryo has become a fully-developed larva within the egg, the latter, in the case of those having a deutovium stage, ruptures along the inner membrane, in the line of the original split, *i.e.* along the pale band, and the escape of the larva commences. I have watched this very carefully under the microscope in the case of *Damæus geniculatus* and *D. clavipes*. The rupture commences at the small end, which contains the rostrum of the larva; the long legs are doubly folded upon the side of the body, the long hairs of the back lie flat, and pointing straight backwards. The front part of the cephalothorax, whenever I have watched the process, has protruded first. It was slowly followed by the anterior pair of legs, then the whole cephalothorax and the second pair of legs

gradually made their appearance, the progress being very slow. A long delay now took place, during which the various parts stiffened, and assumed their permanent positions, the hairs becoming more or less perpendicular, the hinder pair of legs (for the larva is hexapod) remained in the shell until the last, pushing against the inside of one half while the back rested in the other, and thus slowly opened it.

As the different parts emerged everything moveable was kept continually moving, a strange sight in these slow and lazy creatures; the legs were worked in all directions, and it was amusing to watch the parts of the mouth constantly going, the chelate mandibles, usually so difficult to see, were protruded and retracted independently, and kept ceaselessly snapping. The escape from the egg lasted six to eight hours: I cannot say if it takes as long in a state of nature.

The Larva.

The larva of one of the *Oribatidæ* is invariably hexapod. All the six legs are monodactyle, the tridactyle claws are confined to the imagos. The larvæ are always soft, and usually have but little colour, although in some species, as *Hermannia picea*, *Oribata punctata*, &c., they show a considerable amount; and the colour which results from the alimentary canal, filled more or less with food, showing through the transparent cuticle, is of course visible.

In all respects, except those above mentioned and the smaller size, the larva ordinarily closely resembles the nymph; and, as the latter is the more lasting and important stage, the descriptions will be chiefly given in treating of that stage; in those instances where the larva is known to me to differ from the nymph, the difference will be found noticed in the description of the particular species; it does not, however, in any instance, differ so much but what it would be readily

known; whereas, as a rule, the larva and nymph are totally unlike the perfect form.

The creature remains only a comparatively short time in the larval state, usually, in the species which I have reared, from three weeks to two or three months. I have had *Leiosoma palmicinctum* about seven weeks, *Oribata alata* about three weeks, *Nothrus theleproctus* over two months, in the larval state; and other species for varying periods. I cannot tell how these periods correspond with those which would have been occupied in a state of nature.

In my opinion the larva does not undergo any ecdysis until the one which occurs at the time of its change to the nymphal condition; I say in my opinion, because Dr. G. Haller, of Bern, has expressed a contrary view,* which he founds upon his dissection, or perhaps I should rather say manipulation, of the larva of *Damæus geniculatus*. This larva has a habit, which will be found referred to in the chapter relative to that subject, of covering its back with a thick coating of mud or dirt; by carefully pulling this to pieces with needles, Haller discovered, as he considers, the remains of several larval skins mixed up with it. Supposing Haller to be correct in this, it is not convincing to my mind, because in this species, and in the closely allied *D. clavipes*, the notogaster of larva, nymph, and imago appears to exude some glutinous matter which causes things to stick to it, and those specimens which I have reared or retained in confinement have managed, by means which will be found described in the same chapter, to collect a large proportion of the loose objects in the cell and pile them on to their backs. In this they seem to have some power of selection, for imagos of *clavipes*, which have been perfectly clean when I put them into a cell which contained eggs, have, within a very short time, had every egg in the cell fixed firmly to their backs; and therefore it is more

* "Miscellanea acarinologica," 'Mittheil. der Schweitzen Entom. Gesellschaft,' No. 4, p. 507.

probable that the cast skins have stuck to the back than that they have remained on through the ecdysis. Whatever conclusion may be drawn from the above remarks, I can only say that, amongst the very numerous larvæ of *Oribatidæ* which I have reared and kept alive, and have observed as closely as circumstances permitted, I have not ever, in any instance, succeeded in detecting any larval ecdysis except the final one.

The process of the change from the larval to the nymphal state so closely resembles that from the nymphal to the imaginal, that I have not thought it necessary to describe them separately, and have reserved my observations for the final and more interesting change. During the inert larval period Henkin calls the creature nympho-chrysallis and nymphophan.

The Nymph.

In the name of this stage I have followed Lamarck, who has, as I think very properly, given this name for the active stage in *Orthoptera*, &c., which corresponds to the inert pupal period of *Lepidoptera*, *Diptera*, &c. Dugès, Robin, Fumose, Mégnin, and other authors, have already applied Lamarck's name to the period now treated of in the life-history of *Acarina*, and I gladly follow their example.

Among the *Oribatidæ* the nymph may be defined as the creature after it has become octopod, but before the last ecdysis; indeed, this definition would be correct for almost all *Acarina* except *Dermaleichi*. The nymphal is probably the most important stage in the life of the animal; it is the period of growth, and occupies a very considerable proportion of the existence; it is also the time of gay colouring, and of beauty, where these exist at all. The young nymph fresh from the larval ecdysis is little larger than the fully-grown larva; but the nymph just before its transformation into the imago

is almost as large as the imago itself, although often very different in shape.

The nymph is invariably monodactyle throughout its existence, the cuticle of the abdomen is never hard nor rigid in any species; in some, however, as, for instance, *Scutovertex sculptus*, *Hermannia picea*, *Nothrus theleproctus*, &c., the cephalothorax and the legs are fully chitinised during the later part of the nymphal period. In other species, as *Notaspis lucorum*, *Oribata setosa*, &c., the legs and rostrum, although not fully chitinised, become darker, and somewhat harder, than the rest of the body, but retain a slightly translucent appearance. Again in a few species, as *Damæus splendens*, *Hoplophora nitens*, *Tegeocranus coriaceus*, &c., the whole creature, except the trophi and claws, remains quite colourless and soft up to a very short period before the change to the imago, and never becomes rigid in any part except those last named. During their nymphal life, these species are chiefly, but not invariably, wood-boring or fungus-boring organisms.

The skin of the abdomen, in many species, is highly polished, and reflects exterior objects as clearly as a looking-glass would, but it is more frequently wrinkled, and rather leathery; this is well seen in the nymphs of *Oribata punctata*, *Scutovertex sculptus*, *Pelops acromios*, *Hermannia picea*, &c. This wrinkling allows of the expansion of the creature from growth. After each ecdysis the wrinkles are deep and sharply marked; as the nymph grows they gradually unfold, or straighten, so that shortly before the ecdysis the wrinkles are not generally conspicuous; after undergoing a second ecdysis the nymph emerges larger and again deeply wrinkled, and the same process is repeated.

The colouring of the nymphs varies very greatly. The wood-boring species are, as a rule, colourless or milky, or yellowish-white. Other species, as *Notaspis lucorum*, *Oribata cuspidata*, *N. bipilis*, &c., have a clear, transparent skin, which allows the internal organs and

the food to show through, producing patches of green, brown, pink, and yellow, and giving the nymph a very pleasing appearance. Again, in some species, as *Pelops acromios*, the nymph is reddish-brown; in *Oribata lapidaria* it is almost crimson; in *Oribata parmeliæ*, which feeds on yellow lichen, the nymph is golden yellow, like its food; and other varieties of colouring are numerous.

The nymph undergoes three ecdyses, the third bringing it to the imaginal condition; at least, this has invariably been the case with everyone of the numerous species which I have had in confinement, and another strong evidence is that where the perfect creature carries the cast larval and nymphal skins, in the manner described in Chapter VII, there are, in every instance which I am acquainted with, one larval and three nymphal skins, and no more, to be found on the back of the adult, not obscured nor mixed up with dirt, but perfectly distinct in their natural positions.

Every student of the *Oribatidæ* should recollect that the appearance of the nymph varies greatly during different periods of its existence. When it has only lately passed through the transformation from the larval stage, it is, as a rule, much lighter in colour and flatter on the back, and somewhat more angular in shape, than when it is further advanced; as the nymph becomes older and more fully fed, it usually, *in most species*, becomes more arched on the back and more rounded in outline. Before or during the inert periods, a very great change takes place; the skin swells up like a bladder, the back, even of flat species, becoming quite round; the creature, moreover, becomes considerably longer, from the extensible skin, where the cephalothorax joins the abdomen, being fully extended, instead of the anterior margin of the abdomen overhanging the cephalothorax, as it generally does; all wrinkles and markings are apt to disappear, and the animal would hardly be recognised by anyone not accustomed to watch the development of these creatures. In Plate IV, figs. 2 and 3, I have drawn the

nymph of *Oribata molicomus* in the active and in the inert states respectively, to give an idea of the difference.

The nymphal period is that in which the hairs attain their greatest development and variety. They are an important element in the external appearance of the larger number of the *Oribatidæ* in all stages, but especially so in the nymphal; many have long, simple, setiform hairs, of which *Notaspis lucorum*, *N. lacustris*, and *N. bipilis* are good examples; in the last the two long hairs at the tail are as long as the whole body; it might well be supposed that the species was named from these hairs, but it is not so, it was named by Hermann in 1804, and no one had any suspicion that Koch's *Murcia acuminata* was only a stage in the life-history of *Notaspis bipilis* until I discovered this fact in 1879 by breeding the species. The two hairs from which Hermann's name was given, are two conspicuous, straight spines on each side of the adult, one on the antero-lateral angle of the abdomen, and the other on the coxa of the third leg.

The serrated hair attains an extreme development in the nymphs of *Oribata quadricornuta*, *O. setosa*, &c. The spatulate hair is remarkable in the nymph of *Pelops acromios*, which Koch, taking it for a separate species, called *Celæno spinosa* from this characteristic. The hairs, transformed into straight spines, may be well seen in the nymph of *Oribata sphagni*; but far more remarkable are the great, doubly-curved, serrated spines, which form the homologues of the hairs in the extraordinary nymph of *Tegeocranus latus*; probably, however, even this species is less wonderful in the development of the hairs than *Leiosoma* (*Cepheus*) *palmicinctum* and *Cepheus ocellatus*, in these two each hair round the margin of the abdomen is transmuted into a membranous expansion the shape of a Japanese fan, and strengthened by nervures which are reticulated in the former and branched in the latter species. These fan-like hairs are so large as to

overlap, forming a margin entirely round the nymph sufficiently broad to conceal the cephalothorax and the legs when viewed from the dorsal aspect.

I cannot refrain from stopping here to call special attention to the three last-named nymphs, *viz.* those of *Tegeocranus latus*, *Leiosoma* (*Cepheus*) *palmicinctum*, and *Cepheus ocellatus*, possibly no more bizarre or remarkable creatures exist than these, when nearly fully grown, and bearing on their backs, ring within ring, concentric circles or ovals * of these curious and disproportionately large line-of-beauty-shaped spines formed of clear, colourless chitin, and strongly serrated in the first species, and of the beautiful and iridescent membranous fans in the two latter.

I have said before that the nymphal period is that of growth, it is necessarily also that of feeding; I do not mean by this that the creature does not feed in other stages, but simply that it feeds with special vigour while it is a nymph—at all times, except shortly before each ecdysis, moss, lichen, fungus, or decayed wood, as the case may be, disappears into its mouth with a rapidity which, considering the very minute size of the creature, reminds one of the larvæ of the *Lepidoptera*.

The appearance and formation of the nymphs are of some service in determining whether the genera into which the *Oribatidæ* are divided are really natural groups. Thus in the three genera *Nothrus*, *Damæus*, and *Hoplophora*, which certainly are natural divisions, the nymph, in each instance, strongly resembles the imago. In *Oribata*, also a natural group, the nymphs are utterly different from the perfect form; the same may be said of *Pelops*, *Tegeocranus*, and other genera; and in some of these genera a certain general resemblance runs through the nymphal stages of the various species. Too much stress, however, must not be laid upon this, because it not unfrequently happens that there is a close resemblance between the nymphs of

* See chapter on Habits, page 90.

two or more species, the imagos of which are very different from each other. On the other hand, the converse is not equally true; still, occasionally the perfect forms are extremely alike while the nymphs show considerable difference. Thus the nymphs of *Leiosoma* (*Cepheus*) *palmicinctum* and *Cepheus ocellatus* are so much alike that a collector would naturally calculate upon the imagos being similar, whereas, in reality, they present very different appearances, although, as before stated, I doubt if the genera be properly separated; again, the nymphs of *Oribata punctata* and *Scutovertex sculptus* are extremely alike and the perfect forms are most dissimilar.

I have said above that the nymph of *Hoplophora* closely resembles the adult form, so that one might be recognised from its likeness to the other; probably I should have hesitated in saying this, because Claparède not only did not recognise them, but even took the nymph at first for a mature *Acarus* of a totally distinct family, *viz.* the *Tyroglyphidæ*; and, when it did dawn upon him that they were the same species, he expected to see the mature form turn into the nymph, being misled by his former studies on the hypopial form of *Tyroglyphus*. Having ascertained at last that the highly chitinised form was the adult, and the soft white one the nymph, Claparède maintains that *Hoplophora* passes through an *Acarus* stage: this is repeated by Andrew Murray, who probably only relies upon Claparède. To me it seems that one might say, with as much truth, that a beetle passes through an annelid stage; and, with my experience of breeding *Oribatidæ*, it seems strange to me that an entomologist and arachnologist of Claparède's great ability and carefulness should ever have doubted the so-called *Acarus* form being the nymph of *Hoplophora*, more especially as Nicolet had already figured the nymph; and although Nicolet's figure is far inferior to Claparède's admirable drawings, yet I should think that it is sufficient for identification. Claparède was acquainted with Nicolet's work and frequently refers to

it. The paper upon *Hoplophora* was Claparède's only study of the *Oribatidæ;* had he tried other species he could hardly have failed to discover that they all pass through a soft stage, which, however, possesses all the principal distinctions of the family, and is not by any means properly described as "an *Acarus* stage;" indeed, it rather appears to me that this stage is no more than might reasonably be anticipated. As far as I am aware *Coleoptera*, *Aphaniptera*, and other rigidly chitinised organisms, are usually soft during the period of growth; indeed, it would hardly seem probable that during that time they should be confined in a rigid, non-elastic integument.

Claparède, as one of the proofs that it is an *Acarus* stage, states that the nymph does not possess tracheæ (while the adult does). Kramer says* that it is frequent that *Acarina* which have a tracheal system in the mature stage do not possess it when immature. The possession of tracheæ by the adult is very doubtful in *Hoplophora*.

It is now time to describe the inert stage, which precedes, or perhaps one should say constitutes, the change from nymph to imago; and a somewhat similar stage, to a lesser degree, exists at the change from larva to nymph and at each ecdysis. I shall only describe the final one.

When the nymph is fully fed, and is about to become an imago, it creeps into a hole, or some other sheltered position, stretches out its legs, fixing its large monodactyle claws firmly into the substance it is resting on, and then gradually becomes inert, perfectly motionless, and to all appearance dead; it ceases to feed, and does not exhibit any sign of life if touched or injured. This is the *Teleiochrysallis* of Henkin. I have, in several instances, cut out the supporting substance with the inert nymph upon it, and removed it to a more convenient place for observation, or to the stage of the mi-

* "Grundzüge zur Systematik der Milben," 'Archiv für Naturgeschichte,' 1877, p. 215.

croscope. The length of time which the creature remains in this condition varies a good deal, but probably about a fortnight may be the average period. During the latter part of this time a very slow rhythmic pulsation may be seen in the interior of the creature. If the notogaster be sufficiently transparent, this movement is most easily followed by watching the pre-ventricular glands, which may be seen to be suddenly retracted and then very slowly advanced again to the former position, to be once more drawn back as soon as they reach it. This motion may be well-observed in the nymphs of *Notaspis bipilis*, *Oribata lapidaria*, &c.

If during the inert stage specimens be mounted as microscopical objects I have always found that they collapse, and are not preserved in the inflated condition of the inert nymph. If during the same period the back of the creature becomes concave, I have always found that it dies.

Usually, but not invariably, some twelve hours or so before the perfect Arachnid, which Henkin calls "Prosopon," emerges from the skin of the inert nymph, the latter may be observed to become much darker, and at the end of that time the skin splits. In *Tegeocranus latus*, *Leiosoma* (*Cepheus*) *palmicinctum*, *Oribata alata*, and other species, which I have watched during the final change, the nymphal skin splits first round the posterior edge, and the hinder portion of the abdomen of the adult slowly appears by the skin shrinking from it. This splitting of the skin from behind forward along the edge, and the shrinking of the split skin, proceed almost imperceptibly, the creature remaining perfectly motionless.

After the splitting and shrinking have continued for about five to six hours one may usually see that the respective parts of the imago within were formed independently from the similar parts in the nymph; the legs, for instance, not being formed inside the old legs, which are stretched out, but being folded on the sternal plate or securely packed in the shelter of the

tectopedia. This position of the legs is well seen in a specimen of *Notaspis lucorum* mounted just before the imago emerges from the nymphal skin. When the splitting and shrinking have proceeded sufficiently far the imago at last moves, withdraws its cephalothorax from the fore part of the old skin, like a finger from a glove, and walks off, leaving the old skin, with outstretched legs, in the same position which it has occupied during the whole inert period. If the adult be very soft and white, it sometimes appears to remain in the split nymphal skin until it has become harder and darker. During the final inert period Henkin calls the creature Teleiochrysallis and Teleiophan.

I am not aware that any one before myself has watched the transformations and inert stage of *Oribatidæ*; but considerable differences of opinion have existed, and probably still exist, among naturalists as to what actually takes place during the inert stage in other *Acarina*. Claparède carefully watched the progress of this stage in *Atax bonzi*, and has recorded his observations in one chapter of the work so often cited above; he is of opinion that it is not a mere change of skin, but that the whole creature dissolves, and is entirely reformed—he expresses it as a return to an egg state. It seems to me very like the formation of a perfect insect from imaginal disks. Claparède's view is that a part in the adult is not necessarily formed from the similar part in the nymph, but arises totally independently from the general body substance.

More recently Mégnin has investigated the same subject* in the *Sarcoptidæ* and *Gamasidæ*, and his views as to these two groups fully coincide with Claparède's statement relative to the *Hydrachnidæ*.

It must not, however, be forgotten that Dugès,

* "Note sur les metamorphoses des acariens de la famille des Sarcoptides et de celle des Gamasides," in 'Comptes rendus de l'Acad. des Sc.,' 8th June, 1874. "Mémoire sur les Sarcoptides Plumicoles," 'Robin's Journal de l'anatomie et de la physiologie,' May, 1877, p. 241.

writing at an earlier period, expressed a contrary opinion;* he considered that each organ of the adult was formed from the similar organ in the nymph, and he even says that he cut off one leg from a nymph of *Hydrachna*, and that the perfect arachnid which emerged had only a mere stump instead of that leg. Dugès, however, appears to suggest some amount of dissolution and reformation.

My own opinion as to the *Oribatidæ* coincides with that expressed by Claparède and Mégnin, *viz.* that there is an entire reorganisation, and that the different parts of the body of the adult are formed, not at the expense of the same parts of the nymph, but from the general body-substance. I have, however, elsewhere stated† that I am not able to agree with Mégnin that this applies to the *Gamasidæ*, as, in the species of that family which I have reared, I have not been able to trace the existence of any inert period.

The time which the *Oribatidæ* occupy in passing through their transformations certainly varies considerably in different species, and probably in the same species at different times of the year. I have had nymphs of *Cepheus ocellatus* alive, and remaining in the nymphal state, all through the winter, and probably many other species do the same. The larvæ and nymphs appear to be found at all seasons of the year, but are most abundant in the spring, and rarest in winter.

I am under the impression that the greater number of species and specimens pass the winter either in the egg or the perfect state, and that there is usually more than one, but not any fixed number of broods during the year. It is extremely difficult to keep a single specimen alive from egg to adult, and to watch it, as the watching disturbs it, and it is apt to die. The following table will show, more or less, the time

* "2nde Mémoire sur les Acariens," 'Ann. des Sci. Nat.,' 1834, p. 171.

† 'Journal of the Linnæan Society,' Zoology, vol. 15, 1881, p. 297.

occupied by the immature stages of one or two of those which I have reared in confinement, but it must be remembered that the conditions were unnatural, and may have affected the time occupied. I have reared most of the species from nymph to adult, but not from the egg, nor always from the larva; but in some cases by keeping the adults, I have obtained eggs which have hatched, and been reared through all their stages to a second generation of adults.

Leiosoma (Cepheus) palmicinctum.

12th June, 1881.—Put an egg of this species in a cell by itself.

16th June, 1881.—Egg hatched, and hexapod larva appeared. I placed a small piece of lichen in the cell, to which the larva attached itself.

27th June, 1881.—Larva became inert.

8th August, 1881.—Larva underwent an ecdysis and became an octopod nymph.

8th September, 1881.—Nymph became inert.

17th September, 1881.—After becoming very dark it underwent the first nymphal ecdysis.

11th October, 1881.—Nymph again became inert.

4th December, 1881.—Underwent second nymphal ecdysis.

12th June, 1882.—Became again inert.

20th June, 1882.—Third nymphal ecdysis commenced.

22nd June, 1882.—Perfect creature emerged. Total time occupied one year and ten days.

Notaspis bipilis.

10th April, 1882.—Egg hatched (in separate cell). The record of intermediate stages could not be kept in this case; but,

28th June, 1882, perfect creature emerged. Total time occupied seventy-nine days.

Oribata globula.

10th July, 1881.—Found several living larvæ in a dead adult female, put them together in a cell.

22nd July, 1881.—All except three had died.

27th July, 1881.—Two underwent ecdysis and became nymphs.

12th August, 1881.—One nymph became inert.

17th August, 1881.—It underwent first nymphal ecdysis.

29th August, 1881.—The remaining larva died, never having become a nymph.

21st September, 1881.— The nymph again became inert.

25th September, 1881.—Underwent second nymphal ecdysis.

17th March, 1882.—The nymph died before its final ecdysis, the second nymph having died previously.

Damæus nitens.

17th May, 1883.—Put several adults in a cell with a small piece of decayed wood, and a small piece of mouldy cheese.

A few days afterwards they laid eggs.

25th June, 1883.—The first perfect forms emerged, having passed through the whole of their changes in this short time.

Finally, I may say that, until I traced the life-histories, as far as I know, the immature stages of eight species only were known. Nicolet, the only writer who has dealt with the subject, gives eleven, but as to three he is certainly in error. The species he traced are: *Pelops acromios*, *Oribata punctata*, *Eremæus tibialis* (not yet recorded in Britain), *Nothrus spiniger*, *Damæus geniculatus*, *Hermannia picea*, *H. arrecta*, and *Hoplophora dasypus*. In all other species the life-history is entirely my own tracing.

CHATER VII.

HABITS.

Oribatidæ have one habit which makes the others difficult to observe; this is their avoidance of light. They are creatures without any visible eyes, and yet they are very sensitive to light, and almost all species escape from it as soon as they can, and they are disturbed and uncomfortable as long as they remain in anything like a strong light. As they are minute creatures, requiring a microscope to observe them at all, and as they are mostly black or dark-brown in the adult stage, and therefore absorbent of light, it is almost impossible to obtain light enough to see them by without disturbing them too much for their habits to be ascertained; for it is evident that a creature must not be frightened or ill at ease if its habits are to be correctly observed.

Probably the most singular and interesting habit among the *Oribatidæ* is that of carrying a portion of their cast skins. This curious arrangement is found chiefly among the nymphs, but some of the adults, as *Damæus verticillipes*, *Nothrus theleproctus*, &c., do the same. Of course the larvæ cannot do it, as there are not any cast skins for them to carry. The object of the provision is probably to provide an extra protection to soft and delicate parts; this is a very good explanation of the arrangement, being more common with the nymphs than with the adults, as the former are almost invariably soft, while the latter are usually hard. And it may be observed that, in many genera, where certain species carry the cast skin, the other species have

different modes of protecting themselves. It may also be remarked that the genus *Nothrus*, which is a genus in which two of the adults carry the cast skins, is almost the only genus in which the body is usually comparatively soft in the adult.

The mode in which the cast skin is carried is always the same in the same species; and the simplest form is that, at the ecdysis, the old skin, instead of splitting irregularly or variously in different individuals, splits exactly round the periphery of the abdomen or in some other fixed manner, the split being quite even and alike in all examples of the same species. The result of this, where the split is, as it most commonly is, round the periphery, is that the creature emerges from the lower portion of its exuvium as if the old skin were a box, carrying with it, on its back, the notogastral portion of the old skin, which would correspond exactly with the lid of the box.

This notogastral skin shrinks a little after the splitting process, and this shrinking causes the old notogastral skin to cling more closely to the back of the creature, in spite of which it occasionally falls off, and then looks like an oval shield. Of course the process is repeated at each ecdysis, except generally the final one; and as each successive cast notogastral skin is larger than its predecessors, the adult, where it carries the skins at all, carries one larval notogastral skin, forming an elliptical or shield-shaped centre to the back, and being the highest portion of the abdomen. Around this are three rings, composed of the three nymphal skins, each lying below, and each extending beyond, those before it. This mode of carrying the whole cast notogastral skin flat on the back and concentrically is not much found amongst the adults, but is common amongst the nymphs; those of *Tegeocranus latus*, *Leiosoma* (*Cepheus*) *palmicinctum*, and *Cepheus ocellatus* are excellent examples; in all of them the cast notogastral skins are elliptical, and lie not only concentrically with regard to each other, but they also

leave a margin of the existing notogaster of equal width showing all round. As each cast notogastral skin carries its own row of spines or membranous expanded hairs attached to its periphery, this contributes largely to giving these nymphs their singular and beautiful appearance. In *L. palmicinctum* the hairs in this manner cover up the entire creature except the larval cast skin. In other species the notogastral cast skins are still flat, but they are not concentric, each skin is a little further forward than the previous one, so that the skins of the former periods form a series overlapping each other, and partly projecting behind the posterior end of the abdomen of the existing creature; in these species the cast notogastral skin is more usually shield-shaped. *Nothrus theleproctus* and *Eremæus oblongus* are good examples of this mode. In other species the cast skins have the same arrangement, the latest skin being always the furthest forward, but they no longer lie flat upon the body, but partly shrivel up and appear like a series of jelly-bags, each partly within the other, so as to form an elongated cone, which extends, some way behind the body of the arachnid, and causes a round abdomen to appear a totally different shape from what it really is. No better example of this could be found than the adult form of *Damæus verticillipes; Damæus monilipes* is also an instance of this mode. In other species, again, the cast skins, instead of being evenly spread out in a regular shape, are crumpled up and adhere in a formless pile to the notogastral hairs mixed with other débris. This method is seen in *Damæus clavipes.* Other species do not carry the whole of the notogastral skin, but only a small portion of the last one. Thus the adult of *Nothrus segnis* has two long apophyses, one at each angle of the posterior margin, each bearing a long spatulate hair; the nymph, which is very like the adult, has two long conical tails in the place of these apophyses; the adult carries the last cast skin of these tails and a narrow strip of skin along each side, which

forms a mode of attaching the cast skin of the tail to the adult arachnid. The cast skin of the tail fits over the apophysis like an extinguisher over a candle, so that the apophysis, although existing, is not ever seen unless its membranous cap be removed or come away of itself.

As the portions of the cast skins which are carried are not, as a rule, fixed in any manner, they occasionally drop off, and species which ought to have them are thus not unfrequently seen without, or with less than the proper number. One or two other species have them so loosely attached that they only stay on for a short time; thus the imago of *Hermannia arrecta* sometimes carries the cast notogastral skin of the mature nymph for a very limited period only, and is afterwards seen without it.

The fact that, as the tiny creatures mature, they carry more cast skins, one more for each ecdysis, and that they occasionally lose some of the cast skins, has induced Koch, who was not aware of the habit, and looked on all the nymphs as separate adult species, to make a considerable number of species out of such a form as *Nothrus theleproctus*, that is to say, a separate species for each additional cast skin, and one for the same thing without any cast skins at all.

Another very quaint habit of some of the *Oribatidæ*, which also doubtless serves as a protection, is that of piling their backs with dirt or rubbish, so as to form an artificial covering. This, as far as I know, is confined to two genera, *Nothrus* and *Damæus*; in the former genus the greater part of the species have the back flat, or slightly concave, and soft, even in the perfect stage. On this convenient surface both nymphs and adults manage to pile up a considerable quantity of dirt and rubbish, which they always carry about with them. *Nothrus horridus* and *Nothrus spiniger* are the best English examples; the other English species do not usually carry dirt.

In the genus *Damæus* also, the species vary; the

nymph of *D. geniculatus* has the back almost always thickly plastered with actual mud, which sometimes forms quite a pile on its back; the adults of some other species do the same *D. clavipes* does not carry mud, but seems to collect all the dry débris and rubbish near it on to its back; most of the other English species have not that habit. The mud or rubbish not only covers the surface of the notogaster, but adheres thickly to all the hairs there; and where there are long interlamellar or other hairs standing up on the cephalothorax, or extending over the rostrum, the two (one from each side) frequently get stuck together, and, with the dirt adhering to them, form a sort of platform on which other dirt is piled, until an artificial rostrum, or horn, is formed high above the real rostrum. This is excessively puzzling to anyone, not accustomed to it, who captures the specimen, This dirt is most difficult to get off, neither hot water, alcohol, nor benzole, seems sufficient to dissolve the gum or glutinous material with which the dirt is fixed.

Another very strange habit, if habit it can be called, which some of the *Oribatidæ* have, is that of covering themselves, or being covered, with a white substance, which completely changes their appearance; thus *Damæus verticillipes* and *D. papillipes* are almost invariably covered with a white dust, which looks as though formed of minute flakes of fine, opaque, white membrane. The adult of *D. verticillipes* is dark, but this dust entirely hides it, and even thickly invests each individual hair; so that, as this is the species that carries its cast skins like a succession of jelly-bags behind it, the creature, as usually seen, is totally unlike the actual imago as it would be if extraneous matter were removed; it appears white instead of nearly black, and seems to be a long-abdomened creature, attenuated posteriorly, whereas, in reality, the abdomen of the imago is nearly globular. It is a remarkable fact that the adult when it emerges from the nymphal skin, and the nymph immediately after the nymphal ecdysis, are

already covered with this white dust. By means of a microscope I have watched the process of casting the skin and have seen the white dust covering the creature as it emerged.

Another very curious mode of covering itself is found in *Pelops lævigatus*, the adult of which escapes from the nymphal skin quite clean, but shortly afterwards commences to secrete a white substance, which looks like alum, and with which the back becomes thickly coated. Apparently as this material dries it cracks all over, with deep, short fissures, through its entire thickness, so that the black back of the arachnid shows at the bottom of each little pit formed by the cracking of the white substance. In *Pelops farinosus* a thinner layer of some white material is stated by Nicolet to follow the form of the elevated, vermiform ridges on the back; I think it probable, however, that, in reality, the ridges themselves are only part of the secretion, as is the case in *Pelops acromios*. *P. farinosus* is too rare a species in England to afford any opportunity for investigation. The above-named substances are not the only things which some of the *Oribatidæ* occasionally carry on their backs. *Damæus geniculatus* and *D. clavipes*, particularly the latter, in all stages, have an odd knack of picking up the eggs of their own or other species, and also other oval bodies, and carrying them about on their backs. How this is done I was for a long time quite unable to ascertain, but they certainly managed it somehow. These eggs are always piled upon the back, never sticking about the legs or sides, but they partly adhere to the long notogastral hairs. I soon concluded there was some gummy or glutinous secretion which secured them. After some trouble I ascertained, in what I think is an indisputable manner, that it is not only their own eggs which they carry. My method was this, I took a perfectly clean specimen of *D. clavipes* and shut it up in one of my glass cells, without any other *Acarina*, but with several eggs of

its own species. In the course of two days it had every egg in the cell firmly fixed on the top of its back, and was walking about carrying them. Again, wishing to carry this experiment a little further, I got some eggs of *D. clavipes*, and on the 29th September, 1881, I bred a larva from one of them, this larva I placed in a cell containing the broken egg-shell from which it had emerged, and several large eggs of a *Trombidium*; in a single night, *viz.* that of 29th September, this little creature had piled on his back, and attached to the notogastral hairs, not only the broken egg-shell, but also four of the large eggs; each of these eggs was more than half as large as the larva, which went crawling about with this disproportionate load upon its back, presenting a most ridiculous appearance. This I repeated several times, always with the same result. How this process was accomplished still remained a mystery, but at last, on the 29th of May, 1882, I was fortunate enough to see it executed. On that day I bred a larva of *D. clavipes* from one of a batch of eggs; this larva did not wait for darkness, but very soon after hatching commenced collecting the other eggs. It went about the cell with its palpi widely extended, when it came to an egg it appeared to feel it carefully with these organs as if to ascertain the size and shape, it then placed the front leg round the egg and slowly drew it against the side of its rostrum. Then, with the claw of the front leg, it lifted up one end of the egg, which consequently rested on the ground on the other end, with its long axis perpendicular, and leaning against the rostrum. The little creature then placed the front leg before the egg, which it seized between the claws of the first and second legs (on the same side), and by their aid rolled, or rather twisted, the egg along the side of its body, against which the egg still rested, until it came to the third leg. The egg was rolled along this leg until it reached the genual or tibia, against which it was pressed, and seemed to adhere to the leg, or the hairs springing

from it, by means of some viscid secretion. The egg being on end and the leg oblique they crossed nearly at right angles. The leg being, as before stated, very long, and the coxa and femur being articulated with universal joints, the distal parts of the hind legs can very easily be raised on to the notogaster, and this the larva proceeded to do, carrying the egg with it, which was thus raised so that one end rested on the notogaster, the position in which the eggs are usually found. It was pressed against the notogaster, and the large perpendicular notogastral hairs, but did not adhere, it remained attached to the leg. Again and again the larva tried, but the egg still continued on the leg; it then struck me that the cell having been uncovered for better examination the creature had possibly become too dry, so that the notogaster was not any longer viscid; I damped the cell, and then my small captive again raised its leg with the egg, and this time it remained attached to the notogaster in the position I had so often seen. Another and another egg was soon raised in the same way, each pushing the one before further on to the notogaster, which at last was covered with eggs.

Haller* says that he found eggs on the back of *D. geniculatus* covered up by a membrane, and he appears to be of opinion that this is a kind of natural pouch for their reception. I cannot help thinking that the eggs had probably been picked up after oviposition, and that the membrane was also extraneous and its presence accidental.

Another habit of the *Oribatidæ* is the well-known and widely distributed trick of shamming dead on the approach of danger, which they do to perfection, so that it would be very difficult to tell whether they were alive or not. This, in some genera, is aided by the special arrangement mentioned in Chapter I.

The principal home of the *Oribatidæ* is in moss of various sorts, but it is by no means the only habitat,

* 'Mittheil. der Schweitz. entom. Gesel.,' 1879, No. 4, p. 507.

Oribata piriformis, *Hermannia picea*, *Eremæus oblongus*, *Notaspis bipilis*, *Oribata mollicomus*, *Nothrus sylvestris*, *Nothrus palustris*, and numerous other species, are chiefly found in mosses; either such as grow on the ground or those that grow on trees, &c. The first three of the above-named species live chiefly in the fronds of the mosses, the different species of *Nothrus* oftener near the roots; but no general rule can be laid down, species not habitually moss-dwellers are to be found there sometimes, indeed, almost all species are occasionally present in it. I am not by any means sure that a large number of the specimens do not come rather to search for minute fungi and lichens growing in the moss than for the mosses themselves.

Lichen is another very favourite resort with this family of *Acarina*. *Leiosoma* (*Cepheus*) *palmicinctum*, *Cepheus ocellatus*, *Oribata parmeliæ*, and *Scutovertex maculatus* are true lichen-loving creatures, seldom found elsewhere; lichen-covered rocks by the seaside are very favorable for them. *Notaspis lucorum* swarms in similar lichen, but is also found elsewhere. *Tegeocranus labyrinthicus* is usually a lichen species.

Fungi seem to be the usual domicile of some species; *Tegeocranus coriaceus* is a fungus species; *Hermannia arrecta* lives there as well as in dead wood; and I am strongly under the impression that many species which do not live in fungi feed upon them, and find this food growing in the places which they inhabit. Many species are also found in great quantities in the débris under furze bushes, the needles of which are riddled by their nymphs. *Pelops*, *Hoplophora*, and others are also very numerous amongst the fallen needles of the scotch fir and other members of the fir tribe in woods: *Oribata orbicularis* is found in great numbers on oak trees in spring; *Pelops acromios* and *Nothrus horridus* are also found there. The various members of the genus *Hoplophora*, *Hermannia arrecta*, *Tegeocranus elongatus*, &c., are wood-boring species.

Tegeocranus latus and others, are found on dead wood; *Damæus geniculatus*, &c., there, and under the bark of trees, &c. *Oribata sphagni* and *Notaspis lacustris* are aquatic.

CHAPTER VIII.

COLLECTING AND PRESERVATION.

Collecting *Oribatidæ*, with a view to using them as examples for scientific purposes, is a process requiring considerable care and patience. This remark is still more applicable if the intention be to retain them alive in order to observe habits, &c. The extremely small size of the creatures, and the dull colouring of the adults, render it difficult to see them; while the brittleness of the chitin, of which the exoskeleton is mainly composed, necessitates lightness of touch in manipulating them when found.

As before stated, the members of this family chiefly live in terrestrial mosses, lichens, and fungi; some, however, are found in decayed wood, others on the leaves of trees, others in grass or low herbage, one or two species on *Sphagnum* under water, or otherwise in fresh water, or on the plants growing therein; some are often found under the bark of trees, and a great number of the species take refuge in winter under stones, or in other sheltered localities. It is needless to say that all these places should be assiduously examined, and that a pocket-lens is a necessary accompaniment to all out-of-door search. In consequence, however, of the difficulties above alluded to, and of the position in which the food-plants grow, it is almost impossible to discover them *in sitû*. Stones can of course be picked up and their under surfaces carefully examined, but moss, lichen, &c., must be differently treated. What I have found best for open-air collecting is to take out a few pieces of white paper, pluck the moss,

lichen, or fungus which seems most promising, spread one of the pieces of paper on my knees, and then to thoroughly shake or crumble the moss or lichen over it, small quantities only of the material being used at a time. The moss or lichen must not be very wet or the *Oribatidæ* will stick to it and not fall off, and it must not be very dry or they will all have abandoned it, or all be dead and spoiled.

Supposing the proper hygrometric condition to have been obtained, the *Oribatidæ* will probably be shaken off on to the paper, which must be examined with a lens. A far better plan, however, is to bring the moss or material home, and examine at leisure under a dissecting microscope, using a plate of ground glass to shake on instead of the paper. A convenient mode of bringing the material home is to take out in one's pocket a number of waterproof sponge-bags, or squares of oil-silk and some thin string or thread; the moss, &c., can then be collected, placed in one of the sponge-bags or pieces of silk, tightly tied up by binding the string round and round the mouth, and then taken home for examination. Only moss from one locality should be placed in each bag or piece of silk, and each parcel should be labelled with the exact place whence the contents came, as then, if a new or rare species be discovered, the place of capture can be again searched for further specimens if required. The object of the waterproof material is to prevent the moss from becoming too dry. *Sphagnum* may be brought home in the same way, but it is useless to attempt to shake or crumble it, it is too wet; the actual plant itself must be examined, which is a most tedious and troublesome process.

Such species as live on the leaves of trees may be conveniently obtained by beating the branches over the inside of a lady's sunshade with a white lining, a small white clap-net of very fine material, or any other suitable expanse of white fabric. The species living in grass or low herbage can be procured by dragging

a butterfly-net of white calico through the grass, &c. In every instance it must be remembered that when I say *white* paper or material, I refer to the catching of the adults; the nymphs and larvæ are usually more easily seen on black.

Very often, if the moss be collected in winter, the *Oribatidæ* will crawl out if it be slightly warmed.

Creatures such as *Hoplophora*, *Tegeocranus*, &c., which live mostly in decayed wood, or in fungus, &c., are conveniently obtained by bringing home pieces of the wood or fungus, and then breaking them up and examining them under a dissecting microscope, as in the case of the mosses.

It must be remembered in collecting *Oribatidæ* that they are very averse to light, and that, consequently, comparatively few will be found in material exposed to bright sunshine; decayed wood, for instance, from the depths of forests is better than that from exposed situations. Of course lichen-haunting species are necessarily found in more open localities, but even in these instances the lichens sheltered from the sun should be selected.

Having found the specimens, the next step is preserving them; how that is to be done depends greatly on the purpose to which they are to be applied. If they are to be retained alive in order to watch habits, they are simply transferred to the cell where they are to be kept; the best instrument for picking out and transferring them is a fine camel-hair brush. If the object be to use them as specimens for the collection, the first step is to kill them; this is extremely difficult to effect by the use of any chemicals, their power of resisting the action of poisons being remarkable, but they are killed almost instantly by boiling water, which also has the advantage of frequently causing ovipositors, mouth organs, &c., to be extended. The mode which I have employed is to pick the living creatures into very small white china saucers, and to keep a spirit-lamp and a small test-tube half filled with water

in a holder at my side. This can be boiled and poured into the saucers very rapidly.

When the specimens are dead the question arises, what fluid they are to be placed in. This will depend upon the mode in which they are to be mounted; if they be intended for dry mounts it will not be necessary to place them in any fluid, they can at once be mounted, either on card like beetles, or in any of the numerous forms of cells so well known for dry microscopical mounting; in which case, before mounting, it is well to dry out the water as far as possible, either by placing the specimen in the exhausted receiver of an air-pump with a dish of strong sulphuric acid, or with freshly-parched oatmeal, or salt, or with acetate of potash, or some other material which has a strong affinity for water, or in any other of the well-known methods.

If the intention be to preserve the specimen in Canada balsam, it may be placed in dilute methylated spirit or dilute alcohol; if it be intended to mount in glycerine it may be placed in a mixture of equal parts of glycerine, methylated spirit, and distilled water, or, in my opinion, a still better mode is to place the creatures, irrespective of whether they be intended for balsam or glycerine, into a mixture of about equal parts of the ordinary acetic acid of commerce and distilled water, or two parts of the water to one of the acid; from this medium specimens can be mounted either in balsam or glycerine.

The next process is the actual mounting. The process of dry mounting on card is too well known to need any description; it seems to me, however, that, from the small size of the objects, this mode of mounting is of little use, as they can scarcely be seen with the naked eye, and cannot be properly distinguished even with tolerably powerful lenses, while the card mounts are not convenient for the microscope.

Microscopical mounts dry in cells are of great service, as they give the natural texture and colour of

the dorsal surface, which are, to a certain extent, lost in balsam and glycerine mounts. I have not in respect to this mode anything to add to the ordinary manuals on microscopical mounting.

Balsam mounts are, in my opinion, far the most useful for general purposes; they are less liable to spoil, and are sufficiently transparent for examination, therefore, at the risk of trenching somewhat upon the province of the above-mentioned manuals, I will describe my usual mode of mounting in this medium.

I do not find that the length of time which the specimens have remained in the acetic acid makes much difference, they mount as well after a considerable period of immersion as when quite fresh, but no better.

I never touch the specimens with any needle or metal tool, as their extreme brittleness renders them specially liable to injury; the instruments which I use are a fine camel-hair or sable brush for moving specimens, and single badger-hairs for arranging them. These last-named hairs are easily obtained from a shaving-brush, and I simply place the thick end of the hair in a split lucifer-match, and then whip the split part three or four times round with fine silk. The mounter should have several of these hairs by him for use as required.

When the specimen is removed from the acetic acid it should be washed well in methylated spirit of ordinary commercial strength, and as much dirt as possible removed in this way. The creature should now be placed on an ordinary glass slip, and the slip laid on the stage of a dissecting microscope. While there, all remaining dirt must be removed from the claws, trophi, and other parts to which it adheres, which is best done with one of the above-named badger-hairs in each hand, or a hair to clean with and a brush to hold the specimen. When the object is clean, the legs must be extended and the creature arranged centrally, or in the required position, with the same implements. The spirit should now be allowed to drain to one

corner by slightly tilting the slip, but *the specimen must not ever be allowed to dry;* when the spirit has run off a small quantity of oil of cloves or turpentine (I prefer the former) should be placed on the specimen, and a small strip of thick cover-glass laid at each side of it, and then an ordinary cover-glass laid over the specimen, being supported by the strips, so that there may not be any pressure on the creature, nor even on the hairs which stand up from its dorsal surface or legs. Several specimens may be arranged under the same cover-glass. The objects should remain in the oil of cloves until all air is gone from the interior and until they are as transparent as is desired. It will be found that during these processes the legs will frequently shrink back into a contracted position; this is especially the case with members of the genus *Oribata* and other genera which have special cavities for the reception of the legs. When it occurs the legs must be again extended with the hair as before as soon as possible, nothing can be done after the creatures are transparent and ready for mounting as they have then become stiff.

A mode of getting over the difficulty of this shrinking back of the legs, which requires careful manipulation, but if well done is very successful, is to place a very thin layer of balsam upon the slide upon which the specimen is to be soaked in oil of cloves; when this layer becomes sticky the specimen is placed upon it, dorsal surface downwards. The mounter must then extend the legs and stick them to the balsam, if they rise up they should be pressed down again with the hair; when they are all fast the body should be brushed over with the smallest possible quantity of oil of cloves to prevent its drying, but without touching the legs. This brushing with oil of cloves must be repeated from time to time as it sinks into the body. When a creature is ready, which can only be learned by experience, a large drop of oil of cloves, not benzole, may be put on; when this has *thoroughly* dis-

solved the balsam, but not before, the specimen may be moved and mounted, or further soaked in oil of cloves.

No rule can be given as to the time required for soaking, it is so varying with different kinds and even with different examples of the same kind; the mounter must judge from experience when the specimen is sufficiently transparent for his purpose; when that time has arrived a drop or two of clean oil of cloves must be run past the specimen, which should be carefully examined to make sure that it is quite clean. If not convenient to mount it then, it may be put by in a small saucer or watch-glass with oil of cloves—*it must not ever be allowed to dry.* If it is to be mounted at once it should now be moved to the final slip, which may have the centre marked by a small spot of ink underneath it, the oil of cloves should be allowed to drain off, a very small quantity of balsam dissolved in benzole may be placed in the centre of the slide, and the creature laid on it; or the creature may be laid on the slide and a similar quantity of balsam prepared in the same manner placed over it. In either case this balsam should be allowed to set a little before more is added, the specimen thus becomes fixed, and does not float and become disarranged. When the first supply of balsam has assumed a slightly pasty consistence a larger supply may be added and the thin cover very gently lowered. Some persons prefer resting the cover on one edge and then lowering the other, so as to resemble the closing of one cover of a book. I, however, usually lay it very gently on in a horizontal position, and as centrally as I can. I prefer that the quantity of balsam should not be sufficient to fill the cover, and I then slowly run in what is deficient under the edge; if this be carefully done the balsam will support the cover, and there will not be any pressure upon the object; if, however, any difficulty be found in this, three small broken pieces of cover-glass of sufficient thickness, or three very

small beads, may be placed equi-distantly under the edge of the cover to support it; in some way it is necessary to guard against even the very lightest pressure.

Having been mounted, the slide should be allowed to dry, either by being placed in the sun, or by very gentle heat on a warm-water oven or plate, or otherwise. This should be continued until the balsam at the edges feels hard. I prefer to turn a ring of white cement, asphalt, or gold-size, round the edge of the cover to finish it off and prevent it catching, but before this is done the edge of the balsam must be quite hard, otherwise the cement will draw the cover down unless it be supported, and will spoil the specimen. A ring of gum-arabic or Bell's cement should be turned round the edge of the balsam before the white cement is put on, otherwise it may run in. The sunk cells now commonly sold are very handy for mounting large specimens. Those who prefer ordinary balsam instead of balsam dissolved in benzole will of course use it; the objection which I find is that it requires the application of a greater heat, which is apt to injure the specimen.

One very troublesome thing which occurs in mounting many of these creatures is, that, although the mount looks perfect when completed, and for some time after, yet when the mounter comes to look at it the next day he finds that, although there is not an air-bubble in the balsam, yet the animal itself appears to be full of air, and is quite black and opaque. This effect is not really produced by air, but is due to the fact that in objects with very narrow passages the comparatively thin fluid in which they have been soaked—as benzole or oil of cloves—runs out, while the balsam does not run in, or does so more slowly; and thus a partial vacuum is left, which is very soon filled by the vapour of benzole or other volatile material, and this cannot easily be got rid of after it has taken possession; the only way usually is to

remount the object. If it be found that this is apt to occur to any species the best way is to mix a little balsam with the oil of cloves in which the object is soaked, it thus gets in gradually; a slight warmth may also assist.

If the above process be carefully carried out the mounter will not be troubled with many air-bubbles, and what few there may be will probably go away if left alone for a short time.

Finally, I would suggest to the mounter not to be very anxious about centering his slides. I would not ever disturb a well-arranged object because it is badly centered; it is every bit as good for observation as if it were in the centre of the slide.

If it be intended to mount in glycerine, the same instruments may be used, but from the acetic acid I transfer the object into a preparation of equal parts of glycerine, methylated spirit, and distilled water; in this medium the object will be arranged just as was done in the oil of cloves for balsam mounts, but longer soaking is required than in oil of cloves. From this preparation the specimen may be mounted in pure glycerine or, better still, in glycerine with a small quantity (2 to 5 per cent.) of camphor water mixed with it. The process of glycerine mounting is very well known; it is the best medium for most of the immature stages. I usually mount the creature in a cell, and place just sufficient glycerine very gently upon it, and then cautiously lower the cover horizontally on to it; if done quickly or carelessly it will drive the specimen to one side. I slightly attach the cover in two or three places only, and put the slide away in a very dry place for a few days; at the end of that time I take it out, and, if the attachments be dry, I then carefully wipe any glycerine away with a wet handkerchief; I then let the slide dry, and turn a ring of gold size round the edge of the cover, and again put it away. When the gold size is *quite* dry I again wipe it with the wet handkerchief, and turn another ring of gold-

size round it. This process is repeated until the wiping does not produce the slightest smear of glycerine. A ring of asphalt or other varnish may then be laid over the gold-size, and the slide is finished; but, at the best, these glycerine mounts will not bear rough usage; they must always be kept flat and not on edge, and they ought to have a fresh ring turned over the asphalt every two years or so.

Instead of mounting in pure glycerine the specimen from glycerine - preparation may be mounted in glycerine jelly or Deane's gelatine; this process is also well known. I usually keep the jelly, while mounting, in a small pot or bottle which stands in warm water; I take it out with a glass rod, getting as small a quantity as possible upon the rod; I keep the rod in the warm water and wipe away all former jelly between every dip. No more heat should be used than absolutely necessary to keep the jelly liquid. I slightly warm the thin cover, either by placing it on a hot plate or by holding it in a cambric handkerchief between the finger and thumb. I have found it far easier to mount in these media in hot summer weather than in winter. I generally dilute Deane's gelatine with a little more glycerine.

Several other media may be recommended for use in some cases, as, for instance, salicylic acid, acetate of potash, distilled water with a small quantity of spirit and a still smaller quantity of kreosote dissolved in the spirit.

However the objects be mounted, the slides should, of course, be labelled with the name of the species and the date and place of capture.

Dissections of exo-skeleton are very instructive; if the creature be too small for this, useful pieces may often be obtained by breaking the animal up by pressure and then separating the pieces with a hair or needle.

It will be found that the genus *Oribata* is the most difficult to mount. It is almost impossible to get such a creature as *Nothrus spiniger* clean if it once

thoroughly acquires its coating of dirt; the best way, therefore, is to breed it.

I have not found it worth while attempting to mount nymphs in the inert stage; they usually collapse. The nymphs of *Oribata punctata*, *Leiosoma (Cepheus) palmicinctum*, *Cepheus ocellatus*, *Scutovertex*, *Tegeocranus latus*, and other firm-skinned nymphs, mount well in balsam, but such as *Cepheus tegeocranus*, *Tegeocranus coriaceus*, and many other soft-bodied nymphs, cannot be successfully mounted in this medium. *Notaspis lucorum* just before the final ecdysis makes a good and interesting balsam mount.

CHAPTER IX.

ANATOMY OF THE EXO-SKELETON.

THE external or dermal skeleton of the *Oribatidæ* consists of a cuticle, which is more or less soft or leathery in the larval and nymphal stages, but is usually highly chitinised, and very hard and brittle, in the adults. There are, however, two exceptional genera, in most, if not all, members of which the leathery consistency persists in the imago; these are *Nothrus* and *Hypochthonius*, but the former genus exhibits the peculiarity better than the latter, in which the cuticle, although it resembles that of many nymphs rather than of an adult form, is semi-transparent, and usually more membranous than leathery in appearance.

The adult cuticle when of the normal character, *i.e.* in all genera except the two above named, varies considerably in general effect; as, for instance, most members of the genus *Notaspis*, all of the genus *Leiosoma*, many of the genus *Oribata*, as *O. globula*, *O. fuscipes*, &c., and some of the *Hoplophora* are highly polished. In other genera, as *Tegeocranus*, *Hermannia*, *Pelops*, &c., it is dull and rough, either with irregular markings, as in *Tegeocranus latus*, or with a nearer approach to a definite pattern, as in *Tegeocranus femoralis*, or with scattered raised dots, as in *Tegeocranus velatus*, &c., but the most usual developments are either a surface finely reticulated by low raised ridges, leaving pits, more or less deep, between them, a form well seen in *Eremæus cymba*, *Cepheus latus*, *Hermannia reticulata*, &c. (see Pl. C,

fig. 12); or else a more or less polished surface closely sprinkled with fine punctures. These punctures vary greatly in size, and probably the highly polished species owe that effect to the fineness, not to the absence, of the punctures, and even the difference between reticulations and punctures is probably one of degree (see Pl. C, fig. 11).

The thickness of the total cuticle necessarily differs greatly in the various species, and in the different parts of the same species; in an average section of the central part of the dorsal shield of *Hermannia picea*, which had been prepared for mounting, I found it about ·005 mm. Doubtless in life the interior, or living layer, referred to below, would have been thicker, as it would naturally shrink in the process of hardening, and the edges of the shield are thicker than the centre.

The **Cuticle** consists of three layers: an excessively thin outer layer, a central layer, which is far the thickest, and an inner layer of a thickness intermediate between that of the two others. Of course this arrangement is not by any means singular, one somewhat similar prevails in Insects, *Crustacea*, *Myriapoda*, &c., but when we come to compare the names which different authors have given to the layers, it is not plain what nomenclature it is best to adopt for them.

Huxley calls the three dermal layers in Crustacea, proceeding from without inwards, *epiostracum*, *ectostracum*, and *endostracum*.* Quekett calls them, in Insects, *epidermis*, *rete mucosum*, and *corium*.† This also is the nomenclature employed by Burmeister,‡ Straus, and others. Lowne calls them *protoderm*, *mesoderm*, and *endoderm*;§ this, however does not seem to agree with the mode in which the last two terms are used by Huxley,‖ Gegenbaur, and others, and

* 'The Crayfish,' London, 1880, p. 192.
† 'Lectures on Histology,' London, 1852, p. 386.
‡ 'Manual of Entomology,' English edition, p. 227, 1836.
§ 'The Anatomy of the Blow-fly,' London, 1870, p. 10.
‖ 'The Crayfish,' p. 141.

which is now more generally approved of. Rymer Jones calls them the *epidermis*, the *rete mucosum*, and the *cutis;* * and doubtless numerous other names are given by different authors.

Gegenbaur† treats the integument as composed of two layers only, but of these he considers the lower one to be double; his translators call them the cuticular layer and the matrix. Pagenstecher‡ takes the same view of there being two layers. Nicolet (op. cit.) also treats of two layers, to which he does not give special names, in the cuticle of the *Oribatidæ;* he evidently considers as one double layer what I think it more convenient to call two layers; he talks of a living internal layer, and a secreted, presumably dead, external layer. It matters but little what names be used so long as the facts be clearly rendered. I propose to adopt Huxley's nomenclature, which has the advantage of not pledging the writer to a special analogy to any portion of the skin in higher animals.

The **Epiostracum**, or outer layer, is an exceedingly thin, colourless, and usually structureless, chitinised stratum; it does not present any trace of cellulation, and, where the ectostracum is sculptured or uneven, it closely follows all the inequalities of the latter, to which it is usually closely attached; in some species, however, this attachment is not by any means so intimate. This quality is remarkably well seen in *Tegeocranus velatus*, in which creature the epiostracum is so loose that it is rare to catch a specimen which has emerged any length of time without finding that some portion of this layer has been rubbed off, and that the loss does not seem to have inconvenienced the creature in the least. Its absence is very conspicuous because the epiostracum in this particular species is dull and covered with raised dots, whereas the ectostracum is smooth and polished. The last remark leads us to consider

* 'Animal Kingdom,' 4th edition, p. 323, 1871.

† 'Elements of Comparative Anatomy,' 2nd English edition, by Bell and Lankester, p. 249, London, 1878.

‡ 'Beiträge zur Anatomie der Milben,' Leipzig, 1860, Heft 1, p. 5.

which layers the principal markings of the cuticle occur in. Unquestionably in the larger number of instances they arise on the endostracum, and are followed by the ectostracum, and more or less closely by the epiostracum; but the last often assumes markings of its own in addition, or, as in the above instance, assumes markings when they are absent from the ectostracum.

When the whole cuticle is broken transversely the epiostracum will generally be found in some parts projecting beyond the broken edge of the ectostracum, and in other places torn away further in; this is due to the fact that the outer layer is the more flexible and does not break so sharply.

The **Ectostracum** is, in most instances, a highly chitinised, brown or black layer, which constitutes the principal thickness of the cuticle; it is structureless, *i.e.* it does not show any sign of cellulation, but it follows the irregularities of surface of the endostracum, and is pierced by numerous pore-canals. It is very hard and extraordinarily brittle. The softness of the cuticle of the larvæ and nymphs, and also the comparative softness of that of the adults of the genera *Nothrus* and *Hypocthonius*, arise from this layer being less highly chitinised than usual. The same cause gives rise to the flexibility at points where that quality is requisite, as at the junction of the pteromorphæ with the notogaster in the *Pterogasterinæ*, &c.

The **Endostracum** is the living layer; it usually shows clear cellulation and a somewhat papillary structure; it doubtless secretes, or gives rise to, the two outer layers; it is usually almost colourless, but is frequently underlaid by pigment, especially in the nymphs.

Having now indicated the material of which the exo-skeleton is formed, I will endeavour to give some idea of its structure and general arrangement.

In doing this I have thought it best to select one or two types, and I have taken, firstly, *Oribata piriformis* (to which the following description primarily refers),

as it is a common species, and one possessing all the parts which are to be found in the more complex exo-skeletons; secondly, I have selected *Nothrus theleproctus* as a common species, and a good example of one of the simpler genera. The variations of other genera or species will be noticed, as far as seems necessary, both in this chapter and where they are described in Part II (page 191, *et seq.*).

What strikes the observer first is, that the creature divides readily and naturally into two regions, the cephalothorax and the abdomen, of which the latter is by far the larger. The two are usually anchylosed in the adults, and have little, if any, movement upon one another; in the exceptional genus *Hoplophora*, however, the cephalothorax works upon the abdomen with a ginglymous joint, and shuts against the ventral surface of the latter. Claparède calls it the "Vorderschild" in this genus (the only one he deals with).

The **Cephalothorax** is usually divided, somewhat in front of the middle, by a more or less distinct line, which bears a decided analogy to the cervical groove of Huxley and others in *Astacus*, which is called nuchal furrow by some authors. The portion in front of this line may fairly be called the rostrum*—it is not, however, separated from the hinder part of the cephalothorax by any constriction or structural difference, the line being rather the nearly obsolete indication of what is a more distinct division in other families. This line is shown in Pl. C, fig. 16, between *1* and *4*. The rostrum, although far less distinct, is doubtless the homologue of the part called "Capitulum" by Kramer,† and "Trugkopfchen" by Haller;‡ it practically consists of a chitinous hood called "Capuchin" by Dufour (Pl. A, figs. 1, 6, 7, 8, *a*), which forms the dorsal skeleton, and which is a mere shell enclosing the cavity of the mouth, the organs of manducation, and the pharynx or some

* This part is not the homologue of Huxley's rostrum in Astacus.

† "Ueber Gamasiden," 'Archiv für Naturg.,' 1882, p. 381.

‡ "Die Mundtheile und systematische Stellung der Milben," 'Zool. Anzeiger,' 1881, No. 88.

portion of it. This hood almost always slopes rapidly down from the level of the dorso-vertex, and it also narrows, more or less rapidly, toward the distal end; ordinarily terminating in a point, sometimes sharp, but more usually blunt and rounded. The edge of this hood, around the opening of the mouth, is the epistome (Pl. A, figs. 9, 10, *ep.*), and the hollow left within the hood, and which contains the mouth-organs, is the camerostomum, a name used by Nicolet, Robin, and others. This camerostomum is almost entirely open below, or rather would be were it not for the labium or maxillary lip (Pl. IX, fig. 3, *f*, Pl. XVII, fig. 3, *f*), which is attached by a membranous joint to the lower and hinder edge of the epistome.

The **Rostrum** is composed of at least three pieces, which, however, are so closely anchylosed as to form one, the juncture being only shown by the thickened line where two coalesce. These lines of juncture are longitudinal (Pl. C, figs. 13, 14), and divide the dorsum into two lateral and one central portion. The latter of these, constituting the superior or dorsal surface, may fairly be called the "frons," being in effect the same part to which Burmeister and others apply that name in Insects, so far as the great distinction between the detached caput and thorax of the one, and the combined cephalothorax of the other, will allow. It is a square or oblong piece, usually only slightly arched, and consequently appearing almost horizontal in transverse section, but approaching to perpendicular in longitudinal section. It is frequently of thinner and more transparent chitin than the lateral pieces, particularly toward the centre of the frons; its anterior margin, which forms a portion of the epistome, is considerably thickened; and this is true of the whole epistome, whatever pieces form it. The lateral portions are more or less triangular, and stand nearly perpendicular; one of the long sides being lowest and forming part of the epistome. These pieces may, I think, not improperly, be called the *genæ*, for much the same

reasons as those given above with regard to the frons. It will be seen that in many species, especially in the genus *Oribata*, the frons and the genæ show distinct points on the epistome; this is well seen in Pl. A, figs. 1, 6, and 7; but it attains probably its highest development in *Oribata cuspidata*, a species which I have thus named from this peculiarity (see Pl. X, fig. 8); here the genæ have encroached upon the frons in front.

Each gena usually bears a curved hair near its distal end; these hairs I call the "rostral hairs," they are characteristic and are ordinarily short, stout, simple hairs, curving inward and forwards (Pl. A, figs. 6 and 7, *b*), but occasionally they are serrated or pectinated. *Oribata quadricornuta* (Pl. VIII, fig. 6, *b*) is an excellent example of the latter form.

As the hood of the rostrum forms the parietes of the greater portion of the camerostomum, this seems the most natural place to describe the trophi; although the camerostomum in which they are contained is partly situated within the portion of the cephalothorax posterior to the rostrum, the hinder portion of the epistome, to which the labium, or maxillary lip, is attached, being distinctly a portion of the hinder division of the cephalothorax.

The **Trophi** are: firstly, the mandibles; secondly, the labium and maxillæ, for these two organs, if they be two, must be treated of together; thirdly, the lingula; fourthly, the palpi.

The **Mandibles** are well known by that name, but Haller somewhat disputes its correctness, and says that they are not true mandibles; he calls them the first "Kieferpaar" (op. cit., note,‡ p. 114). As, however, Dujardin, Dugès, Robin, Nicolet, Mégnin, Claparède, and most other writers upon the *Acarina* call them mandibles, it seems most convenient to retain the term; and, as they lie above what are ordinarily called the maxillæ, it is not altogether an inappropriate one. Heller calls them "Scheide," and Pagenstecher "Schneidendecker," of the mandibles; doubtless they are the

homologues of the cheliceræ of the *Arthrogasta*, a resemblance which is very striking in that remarkable genus or family of mites, *Labidostoma*, Kramer (*Nicoletia*, Canestrini); and cheliceræ would be the best name for them in the *Oribatidæ*, *Gamasidæ*, *Sarcoptidæ*, &c., were it not for the established use of the word "mandibles," and for the fact that there are other families in which the same organs are not chelate.

It matters, perhaps, but little what the organs are called provided we have a clear idea of what they are. One of the mandibles of *Oribata piriformis* (my type species) is drawn at Pl. A, fig. 5, and numerous other drawings of the different mandibles will be found on the plates illustrating the various species. Each mandible (in *O. piriformis*) consists of two joints only; the first large, more or less elliptical, and produced forward, so as to form one limb of the chela in the usual way; the other jointed on to, and working in a hole in, the first.

The ellipse of the first joint is somewhat produced posteriorly so as to form a flattened ridge, slightly curved, and thus slip easily along its course. This mandible is cut away at the posterior lower edge to give passage to the powerful muscles serving it (Pl. A, fig. 5, *D*). The form of the opening is somewhat difficult to show in this drawing, but the reader will understand that the dotted line is a continuation of the edge of the opening, but the part represented by the dotted line would be hidden by the superior side of the mandible. It is needless to say that the mandibles are hollow, except near the points of the chelæ, and chitinous, the chitin becoming exceedingly thick and hard in the actual teeth, or serrations of the chelæ.

These teeth in the species now being described do not spring from the whole of the joint, but each limb of the actual chela has a flattened piece, thinner than the chela, running along its inside edge; it is in this that the teeth are cut. The number of teeth on each side in *O. piriformis* is three, of which the terminal tooth on the

moveable joint is bifid (fig. 5 *A*). The number of teeth varies in different species, and they are sometimes arranged in a double row. At the anterior edge of the opening on the under sideis a small, long-shaped piece of chitin (Fig. 5, *C*), which serves to give attachment to the retractor muscles of the mandibles, which are fastened to it by long tendons, a mode so common in the *Oribatidæ* as to be characteristic. A strong hair is almost always found on the upper or dorsal edge of the mandible a little in front of the middle.

The levator muscles of the moveable joint of the mandible form a broad fasciculus, arising from the inside of the lower side of the first joint and are inserted into the upper angle of the moveable joint.

Two important variations of the mandibles occur in different genera. The first is in the genus *Pelops*; there the mandibles, instead of being elliptical, have a large, almost quadrangular mass at the base, which contains the great muscles and occupies about a third of the length; then they suddenly narrow and become almost rod-like, although hollow, and end in veryminute chelæ, which are scarcely dentate. This form is seen in Pl. I, figs. 1 and 4, and in Pl. II, figs. 5 and 9. The second is still more aberrant; it is found in the genus *Serrarius*, where the general form of the *Pelops* mandible is more or less preserved, but the quadrate portion is shorter and the rod-like part longer and thinner, no longer hollow, and curved instead of straight; the moveable joint is absent so that the mandible is not chelate, and the distal portion of the rod is regularly serrated; thus the whole has become a sawing instead of a seizing and tearing organ. This remarkable mandible is shown at Pl. XIV, figs. 8, 9, 10.

The **Labium** or maxillary lip is an organ which most arachnologists have considered to be formed by the coalescing of the two maxillæ or their basal portions; it is a lamellar chitinous piece, more or less convex exteriorly, usually a semi-ellipse (cut transversely) or else subquadrangular, or more rarely approaching

triangular. It is attached by a membranous joint to the hinder edge of the epistome, and works freely as a lip, partly closing the entrance to the buccal cavity; its size varies greatly in different genera.

In *Oribata* the labium usually about half closes the mouth-opening (Pl. VI, fig. 3), but in *O. punctata* and some others it is larger (Pl. IX, fig. 3, *f*); in *Cepheus*, some *Leiosomata*, &c., it is shorter, and then the breadth exceeds the length (Pl. XVII, fig. 3, *f*). In some *Tegeocrani*, *Eremæus*, &c., on the contrary, it almost entirely closes the mouth-opening (Pl. XXII, fig. 11), while in *Hoplophora* it is usually small, and sub-triangular. Different forms of the organ *in situ* are given on Plate XXIV, and, in addition to the figures above noticed, Pl. A, fig. 2, *f*, may be referred to, and Pl. IV, fig. 5, *h*, Pl. VI, fig. 4, *f*, Pl. XVII, fig. 5, *h*, for the labium detached from the epistome.

In the two genera *Pelops* and *Serrarius* it will be found that the difference of mandible is correlated with a difference of labium; in *Pelops* the latter organ is produced forward almost to a point (Pl. I, fig. 3, Pl. II, fig. 10), while in *Serrarius* it is a shield for the lingula (Pl. XIV, fig. 11).

The **Maxillæ**, which are Nicolet's "Mâchoires" and Claparède's "Cardinaltheilen der Maxillarlippe," may, or may not, be considered as forming part of the labium; at any rate, these organs are firmly united and appear one structure, but they are not in the same plane. The maxillæ are oblong organs, usually slightly geniculate in the middle, the two inclining towards each other, and usually diminishing in width toward the proximal extremity, where they are firmly anchylosed to the inside of the labium. During their course they make a slight turn, so that the distal portions, which stand quite free and advance beyond the labium, present the lateral edge and not the flat surface, to the labium, and to the horizontal; they are not quite perpendicular, but rather oblique when at rest. The distal edge is dentate, the number and form of the

teeth varying in different genera and species, but they are not ever numerous, as far as I have seen. They are sometimes placed in more than one row (Pl. A, fig. 3). Nicolet says that the movement of the maxillæ is lateral; Claparède states that, in consequence of the widening of the hinder parts to form the above described labium, the portions of the apparatus for which (as a matter of convenience) I retain the name of maxillæ cannot work against one another: I incline to agree with Nicolet, for it seems to me that they do work against one another and are the principal organs of manducation. Claparède, I think, forgets that the usually brittle chitin may become flexible and elastic where motion and not rigidity is required, as in the flexible attachment of the pteromorphæ to the abdomen; and it is by this quality that the maxillæ are allowed to be approximated. It seems to me improbable that powerful and conspicuous organs, possessed by almost every species, and placed so as to be efficient if they do meet, and dentate as though for service, should be fixed and functionless; moreover, there are muscles attached to them. They attain their greatest development in *Hoplophora* and are absent in *Serrarius*. The maxillæ, and their attachment to, or fusion with, the maxillary lip or labium, are shown at Pl. A, fig. 2, Pl. I, figs. 4 and 5, Pl. III, fig. 3, Pl. IV, figs. 5 and 13, Pl. VI, fig. 4, Pl. VIII, fig. 3, Pl. IX, fig. 6, Pl. XVI, fig. 9, &c., always *d*.

The **Lingula** is a delicate, membranous projection, usually proceeding from the inside of the labium, and having a triangular or somewhat spoon-like shape; it is frequently more or less fringed with fine hairs, and is doubtless an organ which assists the passage of food into the canal: it is ordinarily hidden by the labium. The lingula is very well developed in *Nothrus theleproctus*, where the hairs attached to the edge are peculiar in form (see also Pl. I, fig. 4, Pl. IV, fig. 13, Pl. XIII, fig. 11, always *g*). In *Serrarius* the lingula is impor-

tant and has become a sucking tube (Pl. XIV, fig. 11). In *Hoplophora* it is noticed by Claparède as triangular.

The **Palpi** appear to be maxillary, not labial, and if this be so it is a strong argument for the lip being composed of the fused basal parts of the maxillæ instead of being a true labium. They are articulated to a shoulder of the so-called labium, just at the point where the maxillæ project beyond it (Pl. A, fig. 2). The palpi are fusiform organs, lying along the side of the camerostomum, and often projecting beyond it; they are not fused with the lip as in *Myobia*, *Sarcoptes*, and, indeed, most of the parasitic *Acari*, but are attached by the base only. The number of joints is usually five; in rare cases, as *Hoplophora*, four; the relative proportions and the shapes vary a good deal. Nicolet has utilised this in describing the genera; the first or basal joint, however, although thick, is the shortest, and the second the longest in all species which I have examined (Pl. A, fig. 4, *1*, *2*) : the second joint is often incrassate distally. The last three joints vary widely in relative proportions, but they usually diminish in thickness towards the apex of the fifth (terminal) joint. The whole palpus during life has commonly a geniculate form; the bend is given by the middle or third joint just as takes place with the legs (Pl. A, fig. 4, *3*). The fifth joint is sometimes produced at the tip as a minute cylindrical projection, which resembles that of the antennæ in some *Lepidoptera* (*Oribata piriformis*, Pl. A, fig. 4); sometimes it is gradate on the outer edge (*Oribata globula*, Pl. V, fig. 9); sometimes almost conical (*Leiosoma* (*Cepheus*) *simile*, Pl. XIII, fig. 4); sometimes beset with long processes, as in *Nothrus spiniger;* but most commonly ovate or elliptical (Pl. XVIII, figs. 4, 12, Pl. XXI, fig. 4, &c.). This joint (the fifth) is usually furnished with numerous fine hairs, which seem to be sensory; the hairs are fewer, but frequently larger on the other joints, they are not usually present on the basal.

The palpi are probably the most mobile organs

which the *Oribatidæ* possess; when the creature is walking they are in continual movement, their points constantly touching the ground or surface on which the animal is walking. The articulations appear to be ginglymous except the terminal one.

Posterior portion of the Cephalothorax.—The cephalothorax behind the cervical groove may be divided into six distinct regions,—a dorsal, a sternal, and on each side a superior and an inferior lateral region. The dorsal may sometimes be found divided transversely into two parts, a narrow anterior slip lying between the frons and the next described division, *i.e.* practically between the cervical groove and the trans-lamella, or if that be absent the place where it would be if present. This part is often a clearly marked descending curve, and to identify it I will call it the "provertex." The posterior portion is trapeze-shaped and is the great dorsal portion of the cephalothorax; it is bounded by the trans-lamella in front, the lamellæ laterally, and the progaster (anterior margin of the abdomen) posteriorly; it is Nicolet's "vertex," but as that name is used in Insects for a portion of the head only, I propose to call it dorso-vertex. It is necessary to treat this part and the lamellæ together, but it is most convenient to commence with the latter.

The **Lamellæ** are two longitudinal, chitinous ridges, extending from the pseudo-stigmata, or the base of the cephalothorax, to the cervical groove or the provertex, and then often prolonged as points standing free, which I call the "cusps." These lamellæ vary greatly in form, size, and in position as regards the perpendicular; their presence or absence and form are extremely useful in classification.

The most ordinary form of the lamellæ is that of two knife-like ridges, one on each side of the dorso-vertex, the edge of the knife being uppermost and the back attached to the cephalothorax, except at the distal ends, where they cease to be so attached, and form the cusps above-named. They approach each other much more

closely anteriorly than posteriorly, and are not quite straight, often slightly undulated; and are wider toward the middle, sinking somewhat toward the pseudo-stigmata, and narrowing at the cusps. They are often almost perpendicular, particularly near the pseudo-stigmata, and may be slightly turned over toward the cusps. This form, more or less varied, may be seen in *Oribata piriformis*, Pl. A, fig. 6, *b*; *Oribata molicomus* and *O. Edwardsii*, Pl. IV, figs. 1, 10; almost all through the genus *Leiosoma*, Pl. XIII—XV, and many others. In some species they have become much larger, less perpendicular, more undulated, and often more transparent or lighter in colour, as in *Cepheus*, Pl. XVI, XVII; *Scutovertex sculptus*, Pl. XVII, fig. 1; *Tegeocranus latus*, Pl. XIX, fig. 1, &c. In others they are thick granular masses, lying horizontally and anchylosed to the cephalothorax, as in *Tegeocranus coriaceus*, Pl. XX, fig. 1; *T. marginatus*, Pl. XXII, fig. 1 &c. Again, they may be thin, almost horizontal, blades, and in this form may become excessively large and coalesce at the posterior part of their inner edges, so as to form a bifid organ, which would hide the cephalothorax, were they not semi-transparent. This attains its greatest development in *Oribata punctata*, Pl. IX; but a highly instructive series to show how the form is attained to by modification of others is *Oribata piriformis*, Pl. VI, fig. 10; *O. fuscipes*, Pl. VII and XXIII, fig. 8; *O. quadricornuta*, Pl. VIII, fig. 1; *O. tecta*, Pl. VIII, fig. 11; and *Oribata punctata*, Pl. IX, fig. 1, Pl. XXIII, fig. 10. In some species the lamellæ become mere thick low ridges (*Scutovertex maculatus*, Pl. XVIII, fig. 9); these may assume the appearance of sculpturing (*Tegeocranus femoralis*, Pl. XX, fig. 9), or may be mere lines, *Eremæus oblongus*. In the genera *Nothrus*, *Damæus*, *Hermannia*, *Hoplophora*, &c., they are either entirely absent, or so profoundly modified as to be scarcely recognisable.

The cusp of each lamella usually terminates anteriorly

in a strong hair, ordinarily setiform, but sometimes spine-like or serrated, which I call the "lamellar hair." The cusp may be pointed and the hair proceed from the tip (*Oribata gracilis*, Pl. XXIII, fig. 3; *O. globula*, Pl. XXIII, fig. 7), or the hair may proceed from a shoulder some way behind the tip of the cusp (*Oribata setosa*, Pl. VII, fig. 3); but very often the cusp is truncate and slightly bifid, and the hair may be set in the indentation between the two points (*Oribata fuscipes*, Pl. XXIII, fig. 8). The points may be of unequal length (*Leiosoma* (*Cepheus*) *simile*), and the indentation between them may become a deep and wide excavation (*Oribata quadricornuta*, Pl. VIII, fig. 1).

The lamellæ are usually joined by a smaller transverse ridge or blade of the same nature, which I call the "trans-lamella;" this is conspicuous in *Oribata piriformis* (Pl. A, figs. 6, 7). It may be cut down in the middle (*Oribata setosa*, Pl. XXIII, fig. 9), but it is more usually a mere line (*Oribata sphagni*, Pl. III, fig. 1; *O. lapidaria*, Pl. XXIII, fig. 6). Sometimes it has become obsolete (*O. cuspidata*, Pl. XXIV, fig. 1, &c.). In *Oribata alata* neither lamellæ nor trans-lamella is visible.

The **Dorso-vertex** is usually more or less sculptured in those genera where the notogaster is similarly ornamented, although the remainder of the cephalothorax may be plain; near its base, almost between the pseudo-stigmata, but usually a trifle in front of them, are ordinarily found two conspicuous hairs or spines, which Nicolet calls the inter-stigmatic hairs or hairs of the vertex; as I do not recognise his stigmata as being such I have called these hairs the "inter-lamellar" hairs; they are so large and frequent that they would naturally be supposed to have an office. It may be sensory, possibly tactile; their position so near to the great ganglion would seem to favour such an idea. They are setiform in most *Oribatæ* and *Leiosomata*, broadly spatulate and very large in *Pelops*. Nicolet differentiates the latter genus by this distinction.

They are serrated in *Oribata setosa*, *O. quadricornuta*, &c.

The dorso-vertex is the part which Nicolet considers as bearing, and covered by, the tectum.

The **Tectum** is a part which owes its name to Nicolet, he alone having pointed out the existence of such an organ; as far as I know it does not exist in any other creatures, and it will be seen from the following remarks that, in my opinion, it does not exist at all.

Nicolet's statement, when treating of the cephalothorax, is as follows:—"In a large number of individuals, forming the first division of the *Oribatidæ*, the upper part of the cephalothorax is dominated, and sometimes entirely hidden, by a lamellar and tectiform expansion of its base, which advances forward, following its declivity" (that of the rostrum), "and assuming a form more or less triangular, the sides of which expansion are raised oblique projections, often prolonged beyond the front" (of the expansions) "and always terminated by two setiform hairs. This apparatus, of the functions of which I am ignorant, but which I consider as a protecting organ, and to which I have given the name of 'tectum,' extends from the base of one stigma to that of the other. The lower face of this organ, where it is opposed to the upper surface of the cephalothorax, is not always free in all species; there even exist some in which it is adherent all its length, and then the tectum is only distinguished by its lateral wings, which, in that case, are usually more developed. In other species this same tectum presents itself as two sub-parallel blades, united by their inner edges, truncated and rounded anteriorly, and through which the body of the cephalothorax may be seen; in this last case the tectum has not any lateral expansions. If I notice these different modifications of the tectum it is because this eminently variable appendage is the best specific distinction that the *Oribatidæ* of the first division present."

Nicolet founds upon variations of this tectum, not

only specific distinctions, but even those of sub-families. He describes it in several places, and evidently regards it as a chitinous shelf, standing free in the air in many species, except that its basal edge is attached to the hinder part of the dorsal surface of the cephalothorax. This shelf, he says, has up-turned lateral edges in most species, these he sometimes calls the raised borders and sometimes the lateral wings of the tectum, they are my lamellæ.

I have always had great difficulty in distinguishing (by this mode of differentiation) the species that Nicolet said had free tecta, attached by their base only, from those which he said had tecta attached by their whole under surface; but I presumed that Nicolet had satisfied himself that there was such a thing as a detached tectum, and it never struck me to doubt the existence of the organ until I came to dissect for the purpose of this book; had I doubted it, and trusted to inspection of the living creature, or of dead or mounted examples, I should probably have still considered Nicolet to be right, for certainly in such species as *Cepheus tegeocranus* (*vulgaris*) which is the very type of Nicolet's free tecta, it looks so like what he described, that I not only should have been, but was deceived; when, however, I came to dissect the organ away from the cephalothorax in this type species, I found, to my amazement, that there was not anything to come. I then passed a hair under the long projecting cusps of the lamellæ and found that there was not any difficulty in carrying it back as far as the point where the tectum was supposed to commence, but that there it stopped, and nothing would get it any further, whereas it ought to have passed equally easily into the supposed space between the tectum and the dorsum of the cephalothorax (or vertex as Nicolet calls it). It then struck me that amongst the very large numbers of specimens of *Oribatidæ* which I had examined I had not ever seen one where any dirt had got into this space, although it gets into

every other place where there is a small hole or depression, and this would be a receptacle just fitted for it. I thought that possibly a thin liquid, such as alcohol, or even water, might run in where a hair or solid matter would not pass; I accordingly tried, but could not get any to run under the supposed tectum. By these methods, but more especially by careful and frequently repeated dissection of various species and by cutting sections, I at last became convinced that the tectum of Nicolet did not exist, and that the appearance of it in *Cepheus*, &c., was an optical delusion.

How does this appearance arise? It seems to me that the explanation is as follows:—The lamellæ are real and existing organs, easily seen by even the most superficial observer, and quite easy to get away by cutting or breaking, but instead of being the upturned edges of a special, detached, horizontal, chitinous organ, they are simply out-foldings of the cuticle of the cephalothorax itself, just as the tectopedia hereafter mentioned are out-foldings, and the apodemata, which serve as places of attachment for so many of the muscles, are in-foldings of the same cuticle. In this manner it is natural that the base of each lamella should be thicker than its summit (or edge) which, indeed, does not include the true cuticle at all but only the chitinous secretions from it; and the lamellæ, being folds of the cuticle, do not spring sharply at right angles from the surface of the cephalothorax, but rise in a curve, produced, so to speak, by the dragging up of the cuticle from each side; thus each lamella has a more or less triangular transverse section, the sides being curved and giving considerable extension to the base, *particularly on the inner side.* The dorsal surface of the cephalothorax, from which these lamellæ spring, is convex; and the broad inner base of the lamella, filling up the depression left by the lower part of the convexity, caused the whole space within the lamellæ to appear, and really to be, higher in level than the parts outside the lamellæ.

Again, the ends of the lamellæ usually rise, forming the projecting cusps. At the points where the lamellæ cease to be attached by their lower edges, and the cusps commence, the two lamellæ are most frequently joined by the trans-lamella which is often a mere line, and has then the appearance of being the anterior edge of the supposed tectum, as it does not rise sharply on its posterior edge but slopes up gradually; it would seem to be a natural result of the folding of the cuticle to form the cusp. A section showing the out-folding of the lamella and the absence of any tectum is given on Pl. C, fig. 16.

The lateral portion of the Cephalothorax on each side is divided longitudinally into two distinct regions, each having roughly the shape of a more or less elongated triangle; the upper one is bordered by the lamella above and by the first tectopedium below; the lower one is the space between the first and second tectopedia. These regions might possibly be held to correspond with Burmeister's pleura and parapleura (in *Coleoptera* and other Insects), but then the term pleura is used in reference to *Crustacea*, which are as nearly allied to *Acarina* as Insects are, to signify lateral portions of the abdomen. It therefore seems more convenient to adopt new terms, and moreover Burmeister's name is confined to parts of the metathorax only; and, although these somatic divisions are much obliterated in the *Acarina*, the regions must be held to be more extensive. I propose to call the upper one (Pl. C, fig. 14, No. 13) the "acro-pleuron," and the lower one (Pl. C, fig. 14, No. 14), the "basi-pleuron;" they are Nicolet's "basilar cavities," but I cannot think that receptacles into which the whole legs can be folded are properly so-called.

The structures which I call **Tectopedia** are blade-like ridges formed by out-foldings of the cuticle along the sides of the cephalothorax; their office is manifestly to afford shelter and protection to the first and second pairs of legs. The first tectopedium is the

upper and anterior of these ridges (Pl. A, figs. 1, 6, 8, Pl. XVII, fig. 3, *r*); it will easily be traced in most of the figures of the genus *Oribata*, &c. In *O. piriformis* it is a thin, curved blade, slightly deflexed and turned, not of equal breadth throughout, but approximately parallel to the lamella, between which and it the tibia and tarsus of the first leg lie snugly ensconced when pressed to the body; the femur lying between the first and second tectopedia, and the genual forming the bend round the end of the first tectopedium (Pl. A, fig. 7, right side). The second tectopedium (Pl. A, figs. 1, 8, 9, Pl. XVII, fig. 3, *m*) lies between the two anterior legs, and is very large and nearly parallel to the first in *O. piriformis* but with a greater curve over. In some species it is shorter and more like a portion of a hollow sphere than the first, it sweeps round the first leg and frequently, at its outer part, forms the posterior wall of a large, cup-like hollow, the bottom of which is a horizontal shelf-like expansion of the side of the cephalothorax. This shelf bears the first leg, and is sometimes very large (*Notaspis bipilis*, &c.), and may be deeply cleft to allow the proximal end of the femur to work freely; in these cases this part of the femur is usually very thin (*Tegeocranus coriaceus*, Pl. XX, figs. 1—3).

The tectopedia vary considerably in different genera and species, but they are usually present in some form or other; they may be entirely absent, as in *Hoplophora* (where the legs are otherwise efficiently protected), *Hermannia*, &c. They may become mere solid chitinous apophyses, of which the second may be much the more developed; and a third bifid apophysis may be situated between the second and third legs (*Damaeus clavipes*, *Scutovertex sculptus*, &c.).

The **Sternal Region** shows clear traces of the somatic division, which is lost on the dorsum. Its construction is that a chitinous plate extends over the whole; along the median line this is greatly thickened, the

thickened portion being the true sternum (Pl. A, fig. 9, *st*, Pl. XX, fig. 3, *m*); this sternum widens out between each pair of legs at the margin of what may be considered to be the somite, and there gives rise to a narrow, thickened band, on each side, extending from the sternum to the acetabulum of the leg. These are not easy to see in life but can readily be seen after mounting in balsam. From the portion of each of these transverse bands next the acetabulum, a strong blade-like apodema, more or less curved in both directions, proceeds inward and affords attachment to the muscles of the legs, &c. The length which these apodemata run along the transverse bands, and consequently the closeness of their inner ends to the sternum, varies greatly in different genera; they are infoldings of the cuticle, probably inter-somatic, and may possibly be considered to correspond to the arthrophragms in *Astacus*, &c. In those genera, as *Oribata*, where the coxæ of the second and third legs are inserted close together, only one apodema is usually found for the two, the first and second apodemata are frequently in effect internal continuations of the tectopedia. The apodemata are shown at Pl. A, figs. 8, 9, 10, *ap*.

At the outer ends of the apodemata are the acetabula of the legs; these vary in form in different species and for each leg. In *Oribata piriformis*, and most usually, they are large, cup-shaped, chitinous pieces, projecting from the inner walls of the parasterna, and forming chambers within which the articulations of the coxæ work (Pl. A, figs. 9, 10, 11).

The spaces bordered by the sternum within, the acetabula or basipleura without, and the apodermata or thickened ridges laterally, are composed of much thinner chitin; I propose to call them "parasterna." They are sometimes sunken, affording depressions within which the legs lie (*Tegeocranus coriaceus*, Pl. XXII, fig. 11).

The **Pseudo-stigmata.**—At or near the lateral ends of the posterior line of the dorso-vertex are found the

conspicuous organs ordinarily called stigmata, one on each side. They are chitinous, usually cylindrical externally, and more or less projecting (Plate A, fig. 6, *s*), with a large external opening, but funnel-shaped and twisted within, and having a very small internal opening, if any (Plate A, fig. 12, Plate II, fig. 12, *s*). The internal surface may have longitudinal ridges (*Damæus geniculatus*, *Leiosoma* (*Cepheus*) *ovatum*, *&c.*). Each pseudo-stigma has an organ proceeding from it, which Nicolet calls a protecting hair, and which I call a pseudo-stigmatic organ (Plate A, fig. 13, and Plates illustrating species, *o*.) I have found it necessary to describe these parts in Chapter X, Section "Organs of Hearing or Smell" (p. 187), and I therefore shall not do so here; they are also referred to in the section on respiratory organs.

At the base of the cephalothorax, where it joins the abdomen, a band of thin chitin descends from the dorsum of the former, and serves as a partition between the two in the upper (dorsal) part of the body. This partition I propose to call the *phragma*; it is shown at Plate C, fig. 17, *w*. The lower lateral angles of this partition are often produced so as to form blade-like processes, which project into the abdomen; these are broad and subtriangular in *Oribata piriformis*, and vary in different species. In *Pelops acromios* they are developed to an abnormal extent, forming long apophyses, shown at Plate C, fig. 17, *y*. In *Oribata piriformis* and other species, two similar apophyses project backward from the phragma near its centre; these are seen in Plate A, fig. 6, on each side of the dotted line *t*. In *Pelops* these short central processes are represented by a single projection of great length and almost rod-like near the phragma, but with a flattened distal end (Plate C, fig. 17, *x*). I propose to call these apophyses the opisthophragmatic processes; they serve for the attachment of muscles, those arising from the central process in *Pelops* being particularly powerful.

The **Legs** are arranged so that the first two pairs are

directed forward, and the third and fourth pairs backward. The first and fourth pairs are usually the longest, but sometimes one and sometimes the other of these is the longer; the second pair is usually the shortest. In the adults all the legs have usually the appearance of being thoracic appendages, and in some immature forms, as the nymph of *Notaspis nitens*, this is even more marked, the thorax running further back on the ventral than on the dorsal surface. The demarcation of cephalothorax and abdomen appears to commence behind the insertion of the fourth pair of legs and to run forward in a curve, passing anterior to the genital plates in the median line; and if it be admitted, as has been generally considered, that a homology with insects must be allowed, and that the first pair of legs in the *Acarina* are modifications of the labial palpi of *Insecta*,—a view which derives great support from the position of the organs in such genera as *Uropoda* (*Gamasidæ*), where they are placed almost in the mouth, and from their being tactile and not locomotive organs in so many genera (*Cheyletus*, *Gamasus*, &c.), then it would appear natural that the legs should be thoracic. On the other hand, in most of the immature forms the apparent division between the cephalothorax and abdomen is a line running almost straight round the body, between the second and third pairs of legs; and this is the appearance usually presented by *Tyroglyphus*, *Glyciphagus*, and most other soft-bodied *Acarina*. Haller is distinctly of opinion that in this order the two hinder pairs of legs are abdominal, and in such forms as *Syringophilus bipectinalis* (Nörner)* they certainly appear to be so; in either event, it is most convenient to treat of all together.

Each leg always consists of five free joints in addition to the ungues; of these the two proximal have universal articulations of some sort, and give the forward, backward, or lateral directions to the appendage; the two universal joints give great freedom of action,

* 'Vierteljahresschrift für Veterinairkunde,' Vienna, 1882, Bd. lvii.

and enable the leg to be lifted right over the back and to be moved in almost any direction. The other three joints have ginglymous articulation. The middle (third) joint is usually the smallest, and is sharply bent or curved, serving to change the direction from more or less horizontal to one approaching the perpendicular, a position in which the two distal joints are usually held in life, except in such long-legged genera as *Damæus*.

In the chapter on terminology I have mentioned some of the different names given by various writers to the respective joints in such *Acarina* as have five joints to the leg. I doubt if adopting the same terms as those used for the vertebrate leg has been any advantage in the *Arthropoda*; but, as it is well established in *Insecta* and *Acarina*, I have not invented new names—I call the joints coxa, femur, genual, tibia, and tarsus.

The first question would be whether the divisions of the sternal surface should be regarded as fixed coxæ, according to the view of Dugès* and others, followed somewhat by Nicolet.† I cannot think so: these divisions do not involve any thickening of the sternal plate, as if anything were laid on; they are only caused by apodemata projecting *within* the body and forming an internal skeleton for the attachment of muscles on their surface, not within any tube or appendage. The fourth leg of *Nothrus palustris* is the only instance I know which seems to favour this view. Fumose and Robin have decidedly rejected it,‡ and certainly the following joint appears to perform the office of a coxa; it is usually a large and important joint, which may be the largest in the leg (*Oribata piriformis*, Pl. B, fig. 15; *O. molicomus*, Pl. IV, fig. 9, both fourth legs). It is inserted by a universal (usually a ball-and-socket) joint, which often projects at right angles from the joint and

* "Recherches sur l'ordre des Acariens," troisième mémoire, 'Ann. des Sci. Nat.,' 1834, t. 2, p. 47.

† Op. cit., p. 405.

‡ "Mém. sur les acariens des genres Cheyletus, &c.," 'Robin's Jour. de l'Anat. et de la Physiol.,' 1867, p. 506.

serves to attach it to the side of the body. The second free joint is usually the great joint of the leg, on which its principal muscular action depends, and seems thoroughly analogous with the femur in insects. Of course this nomenclature omits the trochanter, but it scarcely seems natural to consider either of these two principal joints as being a trochanter, and it may be that the large femur is in reality a combination of the two joints. The next joint is small, and being that at which the bend of the leg occurs its function is recognised at once by the name of genual. The fourth joint seems to me better distinguished as tibia than as leg, "jambe:" Savigny and Robin's mode of never using the word tibia except for one half of this joint, where it is divided, is scarcely known to English zoologists. Finally, the tarsus appears to correspond to the joint so named in insects, and the term does not there signify the claws, which is the sense in which Nicolet employs it; although possibly they may be as much entitled to be considered a joint as the dactylopodite in Crustacea.

The **Coxa** is one of the most varying joints, and is frequently very different in the respective legs of the same individual. In the first leg it is usually comparatively small, but is generally provided with a large spoon-shaped piece which passes inside the acetabulum and forms the articulation, revolving freely within the acetabulum (Pl. B, figs. 1, *1 a*, 2, 3, 4, 5, *b*); outside this there is frequently a constriction, and then a double ridge, which receives the edge of the body-wall.

The coxæ of the third and fourth legs are generally very different from those of the first, they are usually longer, and inserted with a ball-and-socket articulation, or something approaching tc it, instead of the spoon-like process (Pl. B, figs. 15, 16, 17, *b*). In the *Pterogasterinæ* this joint is usually broad, flat, and very thin, so as to slip easily into the narrow space between the pteromorpha and the ventral plate. The

coxa in this case is so shaped as to fit closely to the body (Pl. B, fig. 15); its edge is often provided with a blade-like ridge (Pl. B, figs. 15, *a*, 17, *a*, Pl. IV, fig. 9, &c.). In the *Apterogasterinæ* the coxæ of these legs are ordinarily thicker, the reason for the flattened structure being absent (Pl. B, fig. 16). They may even be almost globular on thin peduncles (fig. 17).

The **Femur**, almost always the largest joint, is most frequently more or less pyriform in the first two pairs of legs (Pl. B, fig. 6), but this is not the case in *Nothrus*, &c. (Pl. B, figs. 7 and 20). In the *Pterogasterinæ* the third and fourth femurs have the same flattened shape as the coxæ of the same legs. In some cases the femur has to pass through, and be guided by, a very narrow cleft in the shelf-like expansion of the sternal surface mentioned above; in this case the joint becomes clavate with a long peduncle and a suddenly enlarged head (Pl. B, fig. 8). The femur is frequently furnished with a blade-like ridge (Pl. B, figs. 7, 18, 19, 20, *a*), even when absent from the coxa (Pl. I, figs. 11 and 12). The blade may be very large and become a specific distinction (*Oribata molicomus*, second leg, Pl. IV, fig. 1, &c.). The articulation of the femur with the coxa is more or less universal, which is often produced in a singular manner, viz. there is a circular opening in the distal end of the coxa, and into this the smaller tubular end of the femur (Pl. B, fig. 6, *a*) fits. The femur has a perpendicular motion, like a ginglymous joint, and its small end also revolves within the hole in the coxa, so that a great variety of positions can be assumed. In the fourth leg (Pl. B, figs. 19 and 20) the articulation is more commonly ball-and-socket, and this sometimes occurs in the anterior legs also. The distal end of the femur may be slightly excavated for the reception of the genual (Pl. B, figs. 19 and 20).

The **Genual** is always the smallest joint in the leg, its lesser end fits with a ginglymous articulation into the femur, with which it makes a strong angle, except

in the very long-legged species (*Damæus*); it is usually more or less curved and is sometimes broader than its length (Pl. B, figs. 9, 10, 21, 22); it has up-and-down motion.

The **Tibia** is a long joint, usually more or less enlarged towards the distal extremity (Pl. B, figs. 11, 23), sometimes more flattened (figs. 12, 24); it has a perpendicular ginglymous articulation with the genual, like that of the genual with the femur, giving it similar movement. In some species this joint is almost globular and may have a thin peduncle (*Damæus monilipes*, first leg).

The **Tarsus** is a joint which varies greatly in proportionate length. In some cases it is short and dilated (*Nothrus theleproctus*, Pl. B, fig. 14; *Scutovertex*, Pl. XVIII; *Tegeocranus elongatus*, Pl. XXII, figs. 9, 10); in other species it is extremely long and fine (*Damæus clavipes*, *&c.*), and every intermediate form is found; it is always largest at the proximal end, and has a tubular articulation, possessing but little motion, being usually held perpendicularly.

At its distal extremity this joint is produced so as to form a short projection of almost colourless chitin (Pl. B, figs. 25, 26, *a*), to this the ungues are attached. It is, I believe, this piece which has induced Nicolet to consider the ungues as a separate joint, for when looked at on the leg it appears, from the similarity of colour, to be a portion of the unguis and not of the tarsus; but when the joints of the legs are separated by nitric acid it will be found that the unguis or ungues separate entirely from this piece which remains firmly attached to the tarsus, and, indeed, in most species, fades into the latter without any distinct line of demarcation.

The **Ungues** are hard and colourless, they are always either monodactyle (Pl. B, figs. 28, 29) or tridactyle (Pl. B, fig. 27). I am not aware of any didactyle claw in the family; those of the larvæ and nymphs are always monodactyle. This is one of the few rules in the family

to which I do not as yet know of an exception, so that a tridactyle specimen may, as far as I know, be safely considered as adult; but the converse will not hold good, the adults of the genera *Hermannia*, *Tegeocranus*, *Hoplophora*, *Damæus*, and some of *Oribata*, being monodactyle.

When there is a single claw it is usually larger and stouter than when the organ is triple.

The tridactyle claws admit of division into two forms, viz. those where the centre claw is decidedly different from the lateral ones (Pl. B, fig. 27) and those where the whole three are nearly (Nicolet says *quite*) similar (Pl. XVI, fig. 7). These are Nicolet's heterodactyle and homodactyle claws; he uses the distinction as a means of classification. I have not followed him, because it does not seem to me that (in English specimens) the three claws ever are quite alike, although much more so in some genera (*Cepheus*) than in others (*Eremæus*); and it seems to me that there are so many intermediate forms at every stage of variation that the character cannot be relied on.

In the strongly heterodactyle forms the middle claw is usually much the thickest, and is more sharply curved than the other two, but it is not generally longer, often rather less so.

The ungues can be moved, independently of the tarsus, by special muscles which are attached to the enlarged proximal ends of the ungues by tendons passing through the tarsus. The claw can be elevated and depressed, but does not seem capable of lateral motion, nor in the tridactyle forms are the three ungues, as far as I know, separately moveable; I have not ever seen one moved without the rest. The lateral may be more or less separate from the central unguis at the distal end, but this is a question of pressure and position, in fact, of external agency, not of the action of divaricator muscles.

It is a somewhat interesting question whether the single or triple claw is to be considered the original

form; the fact of the immature stages being monodactyle speaks strongly in favour of this being the earlier, but the weak lateral claws, without special movement, in many species, seem rather like organs becoming obsolete than in course of development. But little aid is to be found from other families, as a tridactyle claw is rare in the *Acarina*, didactyle being the common form, and monodactyle the next so. In some *Trombidiidæ* the tridactyle claw is found in the larvæ, becoming didactyle in the later stages (*T. fuliginosum*, *T. holosericeum*, &c.).*

Hairs on the Legs.—The arrangement of the hairs upon the legs is as follows:

The coxa is generally devoid of hairs, but may have one or more large hairs; one may be developed to form a large spine (*Notaspis bipilis*, third leg). The femur, genual, and tibia usually have several hairs, either arranged in a whorl near the distal end, which is the commonest form, well seen in *Damæus verticillipes*, or scattered chiefly on the upper surface of each joint (*Oribata alata*, &c.), or chiefly along the outer edge (*Nothrus spiniger*). These hairs are ordinarily fine (*Oribata*, *Leiosoma*, &c.), but they may be spatulate (*Hermannia picea*, &c.) or serrated (*Oribata quadricornuta*, &c.), or may form flabellate membranous expansions (larva of *Cepheus ocellatus*). At the distal end of the tibia of the first leg there is almost always a very long setiform hair arising from the upper median line; it is usually the largest, or one of the largest hairs on the creature: it evidently has a tactile office, and I call it the tactile hair. It often springs from a chitinous apophysis (*Eremæus*, *Scutovertex*, Pl. XVIII, fig. 6). A similar hair, smaller in size, is frequently found on the tibia of the second leg, and sometimes on those of the two hinder pairs. The tarsi are abundantly furnished with fine, scattered hairs, in

* Mégnin, "Mém. sur les métamorphoses des acariens en général et en particulier sur celles des Trombidions," 'Ann. Sci. Nat.,' 6e sér.; "Zool.," t. 4, art. 5.

almost all species, some of these extend by the sides of the claws, and sometimes make it difficult to distinguish a monodactyle from a tridactyle claw, the hairs often being as thick as the lateral claws.

The **Abdomen** is far the largest, and is also externally the simplest portion of the body; its exo-skeleton consists of (1.) an unbroken shield—the notogaster—covering the whole dorsal surface, and usually slightly turned over so as to embrace the edge of the ventral; and of (2.) a simple ventral plate having two large openings, the genital at its anterior, and the anal near its posterior extremity, each of these is closed by a pair of chitinous folding doors. The ventral and dorsal plates are attached by a thick membrane or by muscular bands (Pl. E, fig. 17).

The **Notogaster** (Pl. C, figs. 1, 2) is a large plate, usually more or less convex, but flatter or hollow in *Nothrus*, *Eremæus*, &c., and most frequently round or oval, often truncated or sinuated anteriorly, where it joins the cephalothorax, over which it sometimes projects considerably, it may be with a median process of definite shape (*Pelops*). This margin, which has to be frequently referred to in descriptions, I call the "progaster." The notogaster covers the whole dorsal, lateral, and posterior surfaces of the abdomen, and frequently turns over a little on to the ventral surface. In some of the round-bodied forms of *Damæus* this turning over is carried to a remarkable extent posteriorly, so that the ventral plate becomes quite small. In *Hoplophora* the lateral turning over is very large. The surface is usually smooth and polished, although more or less finely punctured, in *Oribata*, *Leiosoma*, *Serrarius*, *Notaspis*, *Hoplophora*, &c.; rough and often either dotted or marked with hexagonal or other depressions in *Cepheus*, *Tegeocranus*, *Scutovertex*, *Hermannia*, &c.; leathery in *Nothrus*. It often has, near the progaster, a large round or oval spot of clear, light-coloured chitin, much thinner than the rest; of the function of this spot I am entirely ignorant. It is seen

in *Pelops acromios* (Pl. I, fig. 1), *Oribata lapidaria* (Pl. V, fig. 1), *Scutovertex sculptus* (Pl. XVIII, fig. 1), *Oribata piriformis* (Pl. C, fig. 1, *c*), &c.

In the *Pterogasterinæ* the antero-lateral edge of the notogaster is produced so as to form a thin wing-like expansion on each side (Pl. C, fig. 1, *b*), which I call the "pteromorpha"; it is flexible by virtue of the ectostracum being only slightly chitinised along the line of juncture with the main portion of the notogaster, and thus the pteromorphæ are enabled to fold down over the legs. The more usual form is shown at Pl. C, figs. 3, 4, but they may be produced anteriorly to long points (*Oribata punctata*, Pl. IX, figs. 1, 3, 4, 11 *l*), or rounded points (*O. alata*, Pl. X, fig. 1), or they may be strap-like and almost obsolete (*O. sphagni*, Pl. III, fig. 1), or the posterior ends may be free and form long projections (*Pelops phæonotus*, Pl. II, fig. 8).

In some genera of the *Apterogasterinæ* although the pteromorphæ are absent, yet the antero-lateral angles of the notogaster form flat, chitinous projections, which seem to be a first step towards the formation of those organs (*Notaspis lucorum*, *N. licnophorus*, &c.).

The notogaster frequently bears two or more longitudinal rows of hairs, usually white, but they may be black (*Damæus*). These hairs are ordinarily absent or fine and flexible, in *Oribata*, spatulate in *Pelops*, *Tegeocranus*, &c., and thick and spinous in *Nothrus*; but exceptions occur, and other genera vary. There is also often a row of short hairs round the posterior margin, which may be clavate (*Scutovertex*). In the nymphs these notogastral hairs sometimes assume the most fanciful and elegant forms. In *Leiosoma* (*Cepheus*) *palmicinctum*, *Cepheus ocellatus*, &c., they are large membranous expansions, shaped like Japanese fans, or rose leaves (Pl. XV, fig. 1, Pl. XVI, fig. 2). In *Tegeocranus latus* they are great, doubly-curved, serrated spines of extraordinary appearance (Pl. XIX, fig. 2), and other strange varieties will be found.

The **Ventral Plate** is a single chitinous piece, usually

more or less flat but sometimes rounded, which may be excavated to form depressions for the reception of the legs when folded (*Tegeocranus coriaceus*, Pl. XXII, fig. 11; *Cepheus*, Pl. XVII, fig. 3, *t*). It is immovable in all genera except *Hoplophora*, where it can be drawn back towards the dorsal surface at the will of the creature, and usually is so withdrawn when the legs are expanded. The plate is pierced by two large openings of an elliptical or sub-quadrangular shape, the smaller of these is in the most anterior part of the plate and is the genital opening; the larger is near the posterior end of the abdomen and is the anal opening. Each opening is entirely closed, when not in use, by a pair of chitinous folding-doors opening transversely and outward (Pl. C, figs. 5 to 9); the doors are generally more or less convex, and are usually provided with a row of three or more fine hairs near their inner edge. There often is a ridge or projection of the ventral plate, which prevents the genital plates from being drawn inside the body (Pl. C, fig. 8). Close to the anal opening, and between it and the genital, a chitinous piece is always situated within the body just where the edges of the anal plates meet. This piece is shown at Pl. C, fig. 10; it is generally rod-like but curved, with enlarged ends, of which one may be slightly bifid. This piece is placed with the end presented to the anal plates; and its length projecting into the body, it prevents the plates from closing too far in, and it also serves as a point of attachment to the divaricator and possibly the occlusor muscles.

The size of the genital and anal plates varies considerably in different genera; in *Pelops*, *Oribata*, &c., they are comparatively small, whereas in *Hoplophora* they occupy almost the whole ventral surface.

In some genera, as *Leiosoma* (*Cepheus*), the two pairs of plates are widely separated, in others, as *Damæus*, they are almost touching.

CHAPTER X.

INTERNAL ANATOMY.

The internal organisation of the *Oribatidæ* is a subject upon which there are practically only three existing authorities, except my own papers. The first of these is Dujardin,* a keen-eyed observer, who saw a good deal, but, unfortunately, as far as the *Oribatidæ* are concerned, drew conclusions from what he saw which have formed a stumbling-block for most later writers. The second is Nicolet;† and this may be treated as the only substantial work upon the subject. The third is Claparède,‡ whose book is excellent as far as it goes, but it only deals with one very exceptional species of this family, and that with a view to development rather than anatomy.

When I first commenced my own investigations my idea was simply to verify Nicolet's work before repeating his account in my own book, and to ascertain that it was correct, not only for the one or two species he had described, but also for others. As I advanced, however, I found so much variation in different forms, and so many points upon which I was not able to coincide with Nicolet's descriptions, that I was led to devote the greater part of my leisure during the summer and autumn of 1882 and the spring of 1883 to the investigation. It is only fair to Nicolet to

* "Premier mémoire sur les Acariens," 'Ann. des Sci. Nat.,' 3rd ser., t. 3, p. 5; 'Journal de l'Institut,' 1842, p. 316.

† "Histoire naturelle des acariens qui se trouvent aux environs de Paris," 'Archives du Muséum,' t. 7 (1855), Paris.

‡ "Studien an Acariden," 'Zeit. für wiss. Zool.,' 18 Band (1868).

point out that in his beautiful work above quoted he states that in consequence of the minute size, and the hard, opaque, chitinous exo-skeleton of these creatures he found the internal anatomy extremely difficult.

Claparède gives a similar reason for scarcely touching upon the internal anatomy. There cannot be any doubt that Nicolet and Claparède were right as to the difficulty. The largest specimens are under a millimètre in extreme length, and many of the species which I have dissected are not above half that size. Their internal organs are very soft and delicate, but they are possessed of a chitinised cuticle, which is nearly as hard and as brittle as glass, and which is usually quite opaque at all times except immediately after the ecdysis. I first tried observations at that period, but I soon found that I could not obtain much information this way, for, although now that I am acquainted with the organs I can frequently recognise many of them through the notogaster during its short period of transparency, yet the view is too imperfect, and the organs too much hidden by one another for original inquiry. I endeavoured to stain the whole, but entirely failed in getting any stain to penetrate the chitin of the exo-skeleton, or even to run in at joints, stigmata, &c., although I tried the air-pump, hoping it might assist. Finally, after a not very satisfactory attempt at section-cutting, I determined to face the difficulty of the small size, and to rely entirely upon actual dissection.

I soon found that in order to produce a successful dissection the creature must be in good healthy condition, it must not have been kept long in confinement, and it must be dissected immediately after death.

My dissections have in each instance been frequently repeated, *i.e.* upon a considerable number of specimens of each species, as in consequence of the difficulties the naturalist would be too liable to error in judging from one or two instances.

All the figures are made from actual dissections;

they are not calculated, or put together, from the result of consecutive sections. The preparations from which the drawings were made are, in almost all instances now in my possession, stained with logwood, and mounted for the microscope, so that their appearance can easily be verified by any one interested in the subject; of course different opinions may be entertained as to the correctness of the conclusions which I draw from them.

The dissections have chiefly been made under a Stephenson binocular microscope, with powers varying from one inch to half an inch, and low eye-pieces; they have, however, in cases requiring it, been verified and examined under amplifications running up to over 1000 diameters.

I think I may say that the tendency of my mind has been a desire to confirm previous writers, and not to upset their statements. Where I am not able to agree with them it is where I have failed to obtain the same result, and the actual organs before me did not seem to agree with their accounts.

When the notogaster is removed from one of the *Oribatidæ* a thick layer of adipose tissue will be found underlying it, and covering up all the organs. On the surface of this tissue a quantity of scattered pigment granules will frequently be seen, more especially in the nymphs, and these give the bright colour to the nymphs of such species as *Oribata lapidaria;* the integument itself being usually colourless. If this fatty tissue be carefully removed the creature then presents much the appearance shown in Pl. D, figs. 1, 3. The alimentary canal, as far as the commencement of the colon, may be seen in the median line, the edges of the oviducts or testes lying at the sides, below the canal; the tracheæ, where present, may be seen winding over all these organs; and the great muscles of the legs are visible, among which a glimpse may perhaps be caught of the super-coxal glands. The preventricular glands are conspicuous, and the great central

nerve ganglion may be seen overlying the œsophagus. I propose to give what information I can about these organs in the above order or nearly so.

The Alimentary Canal.

In the *Oribatidæ* the alimentary canal is somewhat short and simple, that is to say, there is a comparative absence of convolutions in the hind-gut, and the very numerous cæcal prolongations of the mid-gut found in many allied groups, as the *Aranea*, *Picnogonida*, &c., are reduced to four or possibly to two, which two, however, are usually of great size and importance; they are what I refer to hereafter as the "cæca." The proportions of the parts of the canal and the size and arrangement of the cæca vary greatly in different species, but, as far as my experience goes, the parts of which the canal is composed are always the same. I say "as far as my experience goes" because I have not dissected the whole of the species, although I have dissected a large number of them.

The canal is composed of the œsophagus, the ventriculus, a short small-intestine, the colon, and the rectum, terminating in the anus and anal plates. Of these the first rises from the mouth, the second is almost horizontal, and both are placed in a straight median line; the ventriculus is near the dorsal surface; the small-intestine turns downward and slightly forward, and the colon and rectum are more or less perpendicular, and lie beneath the ventriculus, or almost so (Pl. E, fig. 1).

The canal is of course firmly attached round the mouth and at the anus, but in other parts it seems to float freely in the general body-cavity, with only very slight attachments, if any. If the œsophagus be cut away from the mouth and the rectum from the anus, a hair may easily be passed under the canal and its whole length be drawn out on the hair without further injury. Strong peristaltic movements may be seen in

the ventriculus, cæca, and colon, which must of course be observed at times when the creature is sufficiently transparent.

Taking first *Nothrus theleproctus*, which, being larger, is more convenient for internal dissection than my other type species, *Oribata piriformis*, the alimentary canal is depicted at Pl. E, fig. 3.

The **Œsophagus** is a long, thin, almost straight tract, of small diameter, extending from the mouth to the ventriculus, and having its lowest point at the former, and its highest at the latter place; it has thin walls, capable of considerable expansion and contraction. The cavity of the mouth being larger than the calibre of the œsophagus the latter necessarily widens somewhat as it approaches the former, and this widened portion might not unfairly be termed the pharynx. Posterior to this the œsophagus continues of almost even circumference for the greater part of its course through the cephalothorax; near its posterior extremity it widens. In some species this enlargement is considerable, and then forms an ingluvies or crop—the "jabot" of Nicolet. This writer correctly gives the ingluvies as very much developed in *Damæus geniculatus* (see his work, *Pl. I, fig. 17*, and this book, Pl. E, fig. 4); in *Damæus clavipes* it is even more developed, and is almost as large as the ventriculus (Pl. E, fig. 5). I cannot say that I have ever seen it so large in other genera, but it is no doubt quite distinguishable in many, as, for instance, it is often considerably developed in *Leiosoma palmicinctum*. Nicolet also, in the same drawing, depicts the œsophagus as being constricted at short intervals by circular bands of muscle until it presents a moniliform appearance (Pl. E, fig. 4 *a*). I have not been able to detect this effect in any other species which I have dissected, but the bands of muscle are usual. In the ingluvies of *Damæus geniculatus* these circular bands are beautifully seen after the preparation has been stained with logwood, and indicate that it is an expansion of the œsophagus not a separate stomach.

They are also well seen in *Leiosoma palmicinctum* (Pl. E, fig. 10), where they are crossed by longitudinal bands of muscle. Nicolet further states that an air-bubble is invariably found floating in this ingluvies. My own observations do not quite confirm this, a large air-bubble is certainly to be seen very frequently floating in the canal, but it appears to me that it is not by any means invariably present, indeed, I seldom see it in really healthy specimens, and when present it is more frequently in the ventriculus than in the ingluvies. It is doubtless due to the creatures living chiefly (although not entirely) upon liquid materials derived from vegetable substances and absorbed by a sucking process, which accounts for the presence of liquid in considerable quantities in the fore- and mid-gut, and to those parts not being quite filled with it.

The œsophagus continues the whole length of the cephalothorax and passes a very short distance into the abdomen; if it does not form an ingluvies, it usually is sharply constricted by a circular muscular arrangement almost immediately behind the progaster, at the point where it enters the ventriculus, into which it sometimes slightly projects; there is a very perfect valve, which prevents any food material from returning from the ventriculus to the œsophagus; this may often be well seen by the air-bubble, which, carried by the liquid in which it is floating, will pass down from the œsophagus to the ventriculus, but is always stopped at the valve whenever it has a tendency to return.

The œsophagus enters the ventriculus about the centre of the anterior end, which possibly it may not be proper to call "cardiac" in a creature which is not known to possess any heart.

The **Ventriculus** is the largest and most important portion of the canal. It is a wide sack occupying from half to about two-thirds of the length of the abdomen near the dorsal surface (Pl. D, figs. 1, 3). In *Nothrus theleproctus* the sack is of a shape approaching pyriform, the narrower end being the

anterior; this, however, is rounded, although smaller than the hinder part; the posterior end has a tendency to a blunt median point. The walls of this viscus, although very delicate, are more thick and muscular than those of any other part of the canal except the rectum; in *Damæus geniculatus* they are about $\frac{1}{80}$ mm. thick. It is here that digestion doubtless chiefly takes place; a food mass may most frequently be seen occupying the pyloric portion, or sometimes almost the whole space; it is usually a food ball at the pyloric end partly surrounded by a cap or shell of the more recent food at the cardiac end. From the widest part of the ventriculus, *i.e.* about two-thirds of the length from the anterior end, a large cæcal diverticulum arises on each side, and, in the present species, after standing outward (laterally) so as to form a shoulder, proceeds almost straight backward. In *N. theleproctus*, *N. spiniger*, and *Hermannia picea*, these cæca attain a larger size than in any other species which I have dissected; they are longer than the ventriculus itself, often more than half as long again, and nearly half its diameter, and are of almost even diameter throughout, so that they present a sausage-like appearance; their posterior ends are rounded (Pl. E, fig. 3).

There are probably greater differences between the ventriculi and cæcal appendages in different species and genera of the family than are found in any other part of the canal. In *Oribata punctata* the ventriculus is nearly as wide anteriorly as at any part, and is decidedly narrowed towards the pyloric extremity; the cæca are still long and large, but are no longer of uniform diameter; they are small where they arise from the ventriculus, and gradually increase in size towards the distal extremity (Pl. E, fig. 6). In *Oribata globula* the ventriculus is almost spherical, and the cæca have become shorter than the ventriculus and are elliptical; in *Hoplophora magna*, *Notaspis lucorum*, &c., they have become very small in proportion to the ventriculus, which is widest anteriorly and

prolonged almost to a point behind; the cæca are globular, and are attached to the ventriculus by short peduncles (Pl. E, fig. 2). In the case of *Damæus clavipes* the cæca are not any longer distinctly visible, but are mere enlargements of the outer posterior angles of the ventriculus. *Damæus geniculatus* is an intermediate form in this respect. The form and size of the cæca appear to vary according to age and condition; in lately emerged specimens of *Oribata punctata* they are much shorter and much wider at the proximal ends than they subsequently become. Pl. E, fig. 7, is the form just after the ecdysis.

Nicolet draws the ventriculus and cæcal appendages in *Cepheus tegeocranus* very much of the type above given for *Hoplophora magna*, only that the cæca are more sessile. He draws the ventriculus in *Hoplophora magna* as devoid of cæca altogether, a point in which I am not able to agree with him; he treats the cæca as being simply diverticula of the stomach, without any special office. This probably may be the most obvious and natural suggestion, as far, however, as my own judgment goes, I doubt the correctness of the view. In the very numerous instances which I have examined to the best of my ability, I have not usually been able to detect food in the cæca, either in specimens dissected out or in those observed in life, when the transparency of the chitin enabled me to do so, which was frequently the case, although it is occasionally present in small quantities, particularly near the ventriculus when the mouths of the cæca are large; whereas it is rare to find the ventriculus or colon without food contents. In addition to this the structure of the walls of the cæca, particularly near their distal ends, is different from that of the ventriculus, being thicker and much more glandular, and the lumen smaller in proportion, often very narrow. These considerations lead me to infer that the function of the cæca is chiefly secretory, and not simply that of an extension of the stomach, nor would there be anything

extraordinary in this being so, as a very similar arrangement seems to exist in *Apus*, *Limnadia*, &c., the ends of the cæcal diverticula of the mid-gut being differentiated to form glandular organs; and the same arrangement, carried to a greater extent, prevails among the *Malacostraca*, &c. If these two large diverticula have, as I suppose, the office of secreting fluids necessary for digestion, it would explain to a great extent, the apparent absence of hepatic tubes, an absence observed by Nicolet, who remarks that he was not able to detect any liver. In connection with this subject, however, must be taken the observations which will be found below as to the presence of diffused follicles, supposed by some writers to have a hepatic function, over the surface of the canal; and also those relative to the pre-ventricular glands.

A section cut through the walls of the ventriculus will show exteriorly a thick layer of the above-named follicles (Pl. E, fig. 12, *b*), and within these a membranous *tunica propria*, showing but little structure (Pl. E, fig. 12, *tp*). Within these, in freshly emerged specimens, is a layer of large, more or less hexagonal, epithelial cells, which, however, appear soon to become detached and lost. The appearance of a portion of the ventriculus of a lately emerged *Notaspis bipilis*, as seen from above, is shown at Pl. E, fig. 11.

The ventriculus is sometimes provided with longitudinal bands of muscle on its exterior, and occasionally has slightly developed circular bands also.

The **Small Intestine.**—This portion, forming the commencement of the hind gut, may possibly be considered as simply a part of the colon, from which it is not divided by any valve, but as, although short, it is always present, it may be convenient to treat of it under a separate heading.

The entrance to the small intestine from the ventriculus is always closed by a very efficient valve, which may occasionally be seen to open in order to give passage to the balls of partially digested food.

The hind-gut proceeds from the ventriculus at a point lying to the left of the median line, and near the pyloric end, but not actually at the end; the entrance is situated either at the edge of, or slightly on the under surface of the stomach, but its position varies a little in different species. In *Nothrus theleproctus* the small-intestine starts from the lower part of the edge of the ventriculus almost at its pyloric extremity, and is so wide and short as to be scarcely marked off from the colon (Pl. E, fig. 3, *si*); in *Hoplophora magna* the commencement is much further from the pyloric end, and the intestine itself is smaller, longer, and much more sharply differentiated from the colon (Pl. E, fig. 2, *si*). In *Oribata punctata* the commencement of the small-intestine is much narrower and its length is greater, but it gradually widens posteriorly so that it fades away into the colon, and doubtless slight variations of this kind are numerous. A section cut longitudinally through the small-intestine of *Oribata punctata* is shown at Pl. E, fig. 13; from which the glandular character of its walls may be gathered.

The **Colon** (Pl. E, figs. 1 to 6, *co*) in all species in which I have examined it is an elliptical enlargement of the hind gut, considerably smaller than the ventriculus, and usually clearly defined, particularly at the posterior extremity, where it is provided with a constriction or valve, which generally completely closes the entrance to the rectum; it ordinarily turns downward or slightly forward, so as to be brought more or less under the ventriculus. In a dorsal view, when the notogastral shield has been removed without disturbing the position of the canal, only the anterior end of the colon is seen. In my figures of the alimentary canal the colon and rectum are extended into a horizontal position so as to show them.

Nicolet, in his drawing of the alimentary canal of *Hoplophora magna*, omits this portion of the canal altogether, but he gives one enlargement of the hind gut almost as large as the ventriculus; this enlarge-

ment I presume he intends for the rectum; I can only say that I have not found such an arrangement in any of the specimens of this species which I have dissected; indeed, Nicolet's canal differs so materially from what I have met with that I should think that we were dealing with different creatures were it not that the species is an exceedingly well marked one. The walls of the colon are far less thick and less muscular than those of the ventriculus or rectum. The food mass in the colon frequently assumes a decided green colour, which is lost again in the rectum.

The **Rectum** is usually pyriform, sometimes very small where it arises from the colon, as in *Hoplophora magna*, Pl. E, fig. 2, *r*, and *Oribata punctata*, Pl. E, fig. 6, *r*; sometimes larger, as in *Nothrus theleproctus*, but always distinctly divided from the colon by a sharp constriction. In some species, as *Oribata punctata*, it continues small for some little distance, gradually enlarging until near the anus, at or within a short distance of which it is closed by powerful sphincter muscles. The actual anal end of the rectum is attached round the opening on the ventral surface, which is defended by the anal plates. A series of longitudinal muscles arise from the posterior parts of the rectum and are inserted in the exo-skeleton near the anal plates; they doubtless assist in supporting the rectum and holding it in its place, and probably also assist in defecation.

The rectum itself is muscular, with the bands of muscle arranged circularly; this is very clearly seen in *Nothrus theleproctus*, where, as in the last-named species, the constriction is some little distance from the anal plates, the portion of the canal between the two is comparatively very thin and delicate.

The **Accessory Glands**.—There are two conspicuous glands, not mentioned, I believe, by any other author, which I call "the preventricular glands;" they frequently show like two black spots through the dorsal surface, when at all transparent, particularly in the

nymphs, but they are seen equally well in the adults when the chitin is not too opaque, and they appear to me to be always present. They seem black when seen through the notogaster, but when dissected out they are found not to be really so, but to vary in colour from deep yellow to red and dark brown. These glands are shown in Pl. E, figs. 1 to 9, *pv*, and fig. 15, *pv*, and are seated on the ventriculus at its extreme anterior part, one on each side of the œsophagus just where it enters the ventriculus. The edge of each gland is on the dorsal surface of the ventriculus, so that from the dorsal aspect they look globular, and often are so, but more frequently they are somewhat flattened and show a tendency to a bilobed form, in which cases they extend down the sides of the ventriculus as far as their size renders necessary. They are composed of loosely aggregated cells and are easily broken up if disturbed in most species. Two similarly placed glands appear to exist in such Vermes as *Prorhynchus fluviatilis* and in some *Rotifera*.

It was some considerable time before I could trace the ducts from these glands, at all to my own satisfaction. They are usually so very delicate that it is extremely difficult to detect them, and, although I thought that they followed the course which I ultimately found to be correct, at least in some species, yet I could not feel any certainty; after trying numerous species I experimented on *Leiosoma palmicinctum*, in which I was pleased to find the ducts more distinct. They run, as far I can judge, in an almost straight course along the surface of the ventriculus which they appear to enter just above the cæca; this is depicted in Pl. E, figs. 8 and 9, where they are shown as separated from the ventriculus by dissection, one with its duct is shown at Pl. E, fig. 15. The office of these glands is doubtless the secretion of some fluid useful in digestion. They are occasionally filled with an orange oily liquid. I have found that they are equally well seen in *Notaspis lucorum*. The point, however, where they discharge

cannot be considered as finally settled. Probably, if Burmeister's views were to be followed, these glands, from the place where their ducts seem to discharge, should be called pancreatic, but, as the *Oribatidæ* are vegetable-feeders, the function would not be analogous. The glands and ducts most likely form the homologues of one pair of the anterior cæca of the ventriculus present in so many of the *Arachnida*.

The dorsal part of the anterior portion of the ventriculus and the whole of the cæca are usually covered with a thickish layer of brown follicule-looking cells, which sometimes entirely cover the dorsal surface of the ventriculus; this layer is shown at Pl. D, fig. 1 (yellow and spotted), and in section at Pl. E, fig. 12, *b*. I cannot say that I have ever succeeded in detecting any ducts from this mass; they would doubtless be very fine; but I think that they are identical with those formations which many authors have considered as having a hepatic function.

Thus Mégnin, in his able treatise on the *Gamasidæ*, and on the *Sarcoptidæ* of mammals,* says that he regards this brown granular substance as analogous to that which coats the hepatic tubes of Insects, and as being in fact the liver; and a similar organisation in many Annelids was pointed out long since by Quatrefages,† who assigned it a similar office. Claparède speaks of the ventriculus, &c., and coating of cells as the "Leber-Magen" in the *Hydrachnidæ*, and that most careful anatomist, Croneberg, expressly states his complete adherence to Claparède's opinion, extending it to *Trombidium*.‡ Henkin also calls it Leber-Magen in *Trombidium* (loc. cit.). On the other hand, Leuckart§

* "Mémoire sur l'organization et la distribution zoologique des acariens de la famille des Gamasides," 'Robin's Journal de l'Anat. et de la Physiol.,' 1876, p. 315. "Monographie de la tribu des Sarcoptides psorique," 'Revue et Mag. de Zool.,' 1877, p. 157.

† "Mémoire sur quelques planariées marines," 'Ann. des Sci. Nat.,' 1845.

‡ "Ueber den Bau von *Trombidium*," 'Bull. de la Soc. des Nat. de Moscou,' 1879.

§ 'Die menschlichen Parasiten,' vol. i, Leipzig, 1863—1876.

considered that a similar tissue in the Leech was not hepatic, and Ledig in his histology agreed in this with Leuckart; and the more recent investigations of Professor E. Ray Lankester* seem to point rather to a blood-elaborating than to a hepatic function for this "botryoidal" tissue.

I have not been able to find any salivary glands, nor any appendages to the hind gut.

Parasites.—Many parts of the canal, but more especially the ventriculus, contain Gregarines as internal parasites; these are often so numerous and so large as almost to fill the ventriculus. They are usually elliptical with rounded ends, having a marked constriction near one end, and a very conspicuous nucleus, which stains deeply; their outer surface is generally marked with delicate longitudinal striæ, which are plainly seen in old specimens. These Gregarines are usually found singly, but sometimes in strings of two to four. Nicolet gives longer strings, but I have not seen them. The younger specimens of these Gregarines are frequently found adhering to the inner wall of the ventriculus in such numbers as nearly to cover it.

The Gregarines are often found embedded in the food contents. Some of them are drawn at Pl. E, fig. 16, and a group of young ones attached to the wall of the ventriculus is shown at Pl. E, fig. 12, *g*.

The Reproductive System.

This, next to the alimentary canal, is the largest and most important set of organs in the body; the general arrangement is very similar in the two sexes. When the notogastral shield has been removed the genitalia may be seen lying at the sides of the canal (Pl. D, figs. 1, 2, 3), and in some instances, in the female, when the oviducts are distended with eggs, they seem to have usurped the place of almost all the other organs, and pushed them out of position.

* 'Quarterly Journal of Microscopical Science,' 1880, p. 317.

The **Male Organs of Generation** consist of a large central testis, or more probably one on each side coalescing in the median line by being embedded in, and united by, a flat mass which appears to perform the double office of increasing the quantity of the secretion and acting as a vesicula seminalis; two vasa deferentia; a ductus ejaculatorius; a penis with its accessory organs; and three pairs of copulative suckers.

The **Testis**, treating the whole as one organ, is very large, sometimes appearing to half fill the body, and to force its lobes up to the notogaster; it usually extends the whole width of the body, and forms a saddle-shaped mass which underlies the ventriculus in the centre. It there constitutes an almost flat layer of considerable thickness, deeply indented, both anteriorly and posteriorly, as though it were two paired organs which have met and united in the median line; no sign of suture or demarcation is, however, visible there (Pl. F, figs. 1 to 5, *te*). In addition to this, each side has a tendency to be bi-lobed, and the anterior lobe, which is part of the flat mass, in some species or at some periods, rises much nearer to the dorsal surface than the posterior lobe; the whole varies somewhat in form in different species; in *Nothrus theleproctus* the anterior lobes are large and rounded (Pl. F, fig. 4, *vs*); in *Oribata lapidaria* they are smaller and squarer (Pl. F, fig. 5, *vs*). Along each side of the flat part already described, and partly embedded in it, but not reaching its anterior edge, runs a raised rounded portion, which is oval in *N. theleproctus* (fig. 4) and rather more oblong in *O. lapidaria* (fig. 5); it has the effect of being laid on, and partly sunk in, the flatter portion, but no marked division can be usually found between the two. The substance of both is white, soft, and glandular; but the rounded lobes stain much more deeply with logwood, and then exhibit a mottled appearance. These lobes are probably the true testes, the flatter central portion seems to be

more or less hollow, and to serve as a vesicula seminalis, as well, probably, as an organ secreting some fluid to increase the quantity of the spermatic material; at all events, the walls are very thick and glandular, and in section usually show an exterior membranous coat or tunica propria, lined internally with numerous small, glandular masses, within which is a layer of large flattened cells with very large nuclei.

The coalescing of the testes into an unpaired organ is of course common amongst the *Arachnida*, *e.g.* *Phalangium*; it also reminds us considerably of the arrangement in *Homarus* and in *Pleuroma* and other free-living *Copepoda*, &c., among the *Crustacea*; and in Insects a very close approach is to be found among the *Lepidoptera*, as in *Pontia brassicæ*; and in the embryonic Aphis the generative organs are horse-shoe-shaped.* If the flatter central portion acts also as a vesicula seminalis this would apparently be a departure from the crustacean type.

Nicolet draws the testes in *Damæus geniculatus* as being four oval free bodies on each side, not embedded in any flat central portion. I am not able to account for this; certainly when they are seen through the dorsal surface in transparent specimens, they might be mistaken for it, as the central portion is hidden by the alimentary canal, and the lower lobe and the raised portion might easily be supposed to be separate, both anteriorly and posteriorly.

It may of course be suggested that the raised oval portion is the true testis, and that the central portion has some hepatic or other function and not that of a vesicula seminalis; but the absence of any ducts except the vasa deferentia, the fact that they lead out of the flat portion, the intimate way in which the whole is fused into one mass, and the sperm contents in each, seem to negative such a view.

The **Vasa Deferentia** are substantial tubes of mode-

* Metschnikoff, "Embryologische Studien an Insecten," 'Zeit. für wiss. Zool.,' Bd. xvi, 1866.

rate length, not longer, as a rule, than the testis itself; there is one on each side, springing from the anterior part of the flat portion close to the raised oval (Pl. F, figs. 1, 4, 5, *vd*), and passing downward and slightly forward until they join and open into the ductus ejaculatorius; they have a great resemblance to the paired vasa deferentia proceeding from the unpaired testes in the above quoted case of *Pontia brassicæ;* as a rule they are retracted towards the surface of the testis (as in Pl. F, fig. 4), or to even a greater extent; in Fig. 5 they are shown extended, as when the penis is protuded. There is but little variety in these organs in the species which I have dissected.

The **Ductus ejaculatorius.**—The two vasa deferentia unite, as before stated, at their distal extremities, and are continued by an azygous duct considerably larger in diameter, but short; it is often slightly invaginated, like the finger of a glove, and wrinkled longitudinally, so that it is capable of comparatively considerable extension and contraction; it is shown in Pl. F, figs. 1 to 6, *de.*

The **Penis and Accessory Organs.**—Taking *Nothrus theleproctus* as an example, the penis is a small, chitinous organ, broader near the distal than the proximal end, but almost pointed at each, the distal end being bulbous (Pl. F, fig. 9), near this end there is a chitinous process to which the retractor and extensor muscles are attached. This penis, when retracted, rests in, and is protected by, a second chitinous piece (Pl. F, fig. 8), which is concave, like half a tube (cut longitudinally); the distal end, however, is closed by a semicircular return or turning up of the half tube, so as to form a shallow pocket, in the edge of which is a notch, evidently as a guide to the penis when protruded. The walls of the proximal portion of the half tube are turned outward, and expanded so as to form pyriform blades, doubtless with the object of affording a firmer attachment. The whole arrangement, when not in action, is re-

tracted within a membranous sheath (Pl. F, fig. 6), which is retained in an open or distended condition by two curved chitinous pieces (fig. 8). The penis is, of course, in communication with the ductus ejaculatorius.

This intromittent organ and its adjuncts bear a striking resemblance to those of *Carabus glabratus*, &c., in the *Coleoptera*; the drawing of the penis of one would almost serve for the other; the membranous tube is Burmeister's "præputium," and the chitinous pieces are his horny ridges or bones distending the same.

The whole of the male organs above described, particularly the testis, vasa deferentia, &c., have a marked similarity to those described by A. Croneberg for *Nesæa coccinea*.*

In *Cepheus tegeocranus* there is, on each side, at the anterior part of the testis, a delicate sac, filled with very large, globular, highly refractive cells, appearing like oil or fat cells (Pl. F, fig. 3, *a*); the ducts or passages from these sacs lead toward the *vasa deferentia*, they are delicate and difficult to see. I have not hitherto found them in other genera.

The **Copulative Suckers** (Pl. F, fig. 1, *gs*, and fig. 11).—These, or at all events the organs which bear this name, are three pairs of symmetrically placed suckers or sucker-like structures, lying concealed beneath the genital plates, and only seen when extended or dissected out; they are colourless, transparent sacs, having the form of suckers, and are very large and easily obtained in an extended state in *Hoplophora* (Pl. D, fig. 2). If the creature (*Hoplophora*) be killed by boiling water, the genital plates will probably be open, and the suckers extended through the aperture as drawn.

The organs have, as above stated, a decided appearance of being suckers; but, in allied families of *Acarina*, some authors doubt whether they have that office, and

* 'On *Eylaiis extendens*,' Moscow, 1878 (in Russian).

are inclined to allot a tactile function to them. From their structure I should rather believe in their being suckers, and this was Nicolet's view, but as I have not ever succeeded in finding any of the family in actual coition I am not able to say with certainty. They end in an extremely delicate membranous cup, into which projects a bulb with a tubular peduncle; these are composed of thicker membrane, and the peduncle is surrounded by a chitinous ring (Pl. F, fig. 11, *cr*); behind the peduncle is a short collapsible tube of very clear membrane, and behind this are strong retractor muscles (*rm*).

Copulative Cusps.—Nicolet figures a copulative organ in *Damæus geniculatus*, consisting of three membranous lobes or leaf-like pieces, each fringed with hairs which meet together at their edges, and close the aperture when the genital plates are opened; they, in his drawing, somewhat resemble the three cusps which terminate the ovipositor of the female, but are broader; they do not exist in most other species.

Semen.—As far as I have been able to observe, the spermatozoa are not mobile nor flagellate. I have succeeded in obtaining them from *Damæus geniculatus* by breaking up the testis, and also by pressing the part which appears to me to act as a vesicula seminalis, almost immediately after death, and by cutting sections of both. They are small, elliptical, highly-refractive bodies, about the $\frac{1}{10,000}$th of an inch in the longest axis; they are figured in Pl. F, fig. 10, highly magnified. They closely resemble, except in size, the non-flagellate semen obtained by Mr. F. M. Campbell from *Tegenaria Guyonii* (Guerin), one of the spiders,* although some spiders seem to have flagellate semen. Blanc figures the semen of *Phalangium cornutum* and other *Phalangidæ* as non-flagellate.†

The **Female Organs of Generation.**—The general arrangement and position of these, as before stated,

* 'Journal of the Linnæan Society' (1883).
† 'Bull. Soc. Vaud. de Sci. Nat.,' vol. xvii, pl. vi, fig. 23.

greatly resemble those of the male. It is, however, unnecessary to say that the differences are numerous and important. The organs consist, *firstly* of the ovaries, sometimes with two portions which may possibly perform the office of spermathecæ, although I am inclined to assign them a different function; *secondly* of the paired oviducts, terminating in an unpaired vagina, *thirdly* of the ovipositor, and *fourthly* of the copulative suckers, and also occasionally of some other accessory parts.

The **Ovaries**, or ovary, for it is doubtful whether they should be treated as paired or azygous, consist of a large central sac or gland which underlies the ventriculus in much the same position as that occupied by the testis; this I take to be the true ovary, from the walls of which the eggs are differentiated. It will be found fully developed even when the creature has only lately emerged from the nymphal skin, and when there are not any formed eggs in the oviducts or other genital organs. At this period the walls of the ovary are merely cellular, the ova being almost rudimentary (see Pl. G, fig. 3); at a later period, however, when the eggs have become developed, and when their formation and deposition are in active progress, the ovary may be seen to contain numerous eggs in a considerably more advanced state (Pl. G, fig. 2). This central ovary appears to me really to consist of two paired organs which have coalesced in the median line, much in the same manner as the testis: it is true, that the ovary of *Oribata lapidaria* (Pl. G, fig. 3), *Oribata globula* (Pl. G, fig. 4), &c., is an elliptical organ, giving little, if any, indication of a dual origin, particularly when immature; but in *Cepheus tegeocranus* (Pl. G, fig. 2), in the mature ovary, there are decided signs of a paired structure, a marked central constriction is found here, and the organ approaches to the outline of the coalesced testis. In *Nothrus theleproctus*, when the eggs are developed the ovaries from the two sides have so slight an attachment to each other that they easily separate and then appear as paired, one attached to each oviduct;

but this must not be relied on too much, as it is the effect of degeneration in an exhausted organ.

In *Oribata globula*, *Damæus geniculatus*, Pl. G, figs. 1, 4, and some other species, there is, on each side of the central ovary, and joined to it by a short portion of the oviduct (*od'*), an almost globular expansion of the oviduct (Pl. G, figs. 1, 4, 5, *ut*), having walls much thicker than the other portions of the oviduct and more resembling those of the ovary; these organs, like the central ovary, are fully developed when the creature first emerges from the nymphal skin, and while the other portions of the oviducts are unexpanded and empty. Both the central ovary and these two lateral adjuncts, where the latter exist, stain deeply with logwood, &c., whereas the other portions of the oviduct scarcely take the stain at all. Whether these lateral accessories be uterine chambers, or function as spermathecæ, or glands secreting a vitelline substance, or as one destined to form the egg-shell, or any combination of these offices, is a question which I have not been able to decide quite to my own satisfaction, nor do I see that, as far as the spermatheca question is concerned, it can be certainly decided until we know how copulation takes place, a matter which is not recorded and which I have not succeeded in ascertaining. I have carefully watched, in many hundreds of cases, creatures which I have kept in confinement, but have not ever witnessed the act of coition in any of the *Oribatidæ*, although I have seen it take place very frequently between members of many other families of *Acarina*, as *Gamasidæ*, *Tyroglyphinæ*, *Analginæ*, &c., of which I have not kept a fiftieth part of the number, nor observed nearly as carefully; but the *Oribatidæ* are very small and very dark creatures, which can only be watched under a microscope with powerful light, and they dislike light and avoid it, so that when there is light enough to see them they are not sufficiently at ease to perform the sexual act. The absence of this observation would not materially affect the present

question were it possible to say from analogy whether copulation takes place by the vulva of oviposition, or whether by the anus or some passage in close proximity to it; but this cannot be predicted. In the *Dermaleichi*, unquestionably, the portion of the female which receives the male organ is situated at or near the anus, and far distant from the so-called vulva. Mégnin is of opinion* that it is the anus itself, which is thus a cloaca, and he considers that this is equally the case in all *Acarina*. Kramer, however, has shown† that at least in some *Dermaleichi* the anus is not the copulative organ, but that there is a bursa copulatrix situated a little above the anus and separate from it. I have shown the same thing in *Glyciphagus*,‡ and Haller in some *Dermaleichi*.§ In the *Gamasidæ*, on the contrary, I have found the vulva to be the copulative organ.‖ Pagenstecher states the same thing with regard to *Ixodes*,¶ but does not say if it be from actual observation; and Robin and Fumose in *Tyroglyphus*, apparently from observation. It is, therefore, quite impossible to say at present whether the female is impregnated at the genital or the anal plates; I should suspect that it would be some special organ placed beneath the latter; there is certainly a connection between these and the ovary, but I cannot say whether it is tubular or only a tie; if there be a bursa copulatrix beneath the anal plates, then this organ may well be tubular and the before-named lateral adjuncts of the ovaries may possibly function as spermathecæ, but I incline to consider them as having primarily uterine and possibly secretive functions. In *Damæus geniculatus*, the egg of which has a very hard, chitinous shell, I

* "Mémoire sur les sarcoptides plumicoles," 'Journ. de l'Anat. et de la Physiol.' (Robin's), May, 1877, p. 239; "Mémoire sur l'organization, &c., des Gamasidés," ibid., May, 1876, p. 322, and in his other works.

† "Ueber Milben," 'Zeit. für ges. Naturwiss.,' 1881, Bd. liv, p. 2.

‡ 'Journal of the Quekett Microscopical Club,' 1879, vol. 5, p. 223.

§ "Ueber den Bau der Vögelbewohnenden Sarcoptiden," 'Zeit. f. wiss. Zool.,' Bd. xxxvi (1881), p. 365.

‖ 'Journal of the Linnean Society,' vol. 15. "Zool.," 1881, p. 297.

¶ 'Anatomie der Milben,' Leipzig, 1860.

have noticed that the eggs between the ovary and the globular body are white and soft, but that immediately they have passed the latter they are greatly increased in size and the shell becomes harder and darker.

The **Oviducts**, like the vasa deferentia, are paired ducts, arising one from near each end of the central ovary. They are long membranous tubes, which before the eggs have commenced to mature appear empty, and are then usually corrugated and plicated organs of about even dimensions throughout. They are shown in this condition at Pl. G, figs. 3, 4, *od*; but the reader must understand that these and all the other figures of ovaries are drawn from preparations dissected out and partly extended; when *in sitû* they are so much doubled backward and forward that a drawing of them in their actual position would not give much information. As the eggs are formed, and after they have increased a little in size in the ovary, they pass into the oviducts, where the growth is completed. The oviducts seem to perform the function of a uterus, and the passage of the eggs through them is consequently very slow. The eggs will sometimes be found small, as before stated, in the portion of the oviduct between the ovary and the globular chambers, and large in that between those parts and the vagina. At other times, or in other species, the eggs all appear about the same size, *i.e.* usually all fully grown; this, doubtless, is connected with the different modes of maturing and protecting the ova referred to in Chapter VI. The egg appears to attain its full size in the globular chamber, or the part of the oviduct immediately following it, or immediately following the ovary where the chamber is absent. The oviduct with the eggs mature is shown at Pl. G, figs. 1, 2, *od*, its size then is quite disproportionate to that when the eggs are still in the ovary. The whole oviduct is greatly expanded, and each egg is lodged in a pocket or chamber (formed by the distension of the elastic walls of the duct and

the flattening out of the corrugations), which must not be confused with the above-named globular chamber; this pocket or chamber usually follows the egg in its progress along the duct. In *Damæus geniculatus*, and possibly in some other species, the earlier chambers do not appear to follow, or to subside after the passage of the egg, but persist to some extent; this may be due to the egg remaining an unusual time there while acquiring its chitinous shell. The duct, even when full of eggs, continues to be plicated longitudinally, so that the eggs, when *in situ*, often appear to lie, at the side of the body, one over the other in a bunch; this, however, is a deceptive appearance, they really follow each other in single file along the duct. The ova sometimes lie end to end, sometimes obliquely across the duct, sometimes almost side by side (by means of the stretching of the duct). The position of the eggs is very irregular, I have not ever seen them all following one another, end to end, at regular distances, and regularly increasing in size from the first to the last, as figured by Nicolet, although the end-to-end arrangement is usual in the species he delineates.

These oviducts are what Nicolet calls the ovaries; and what I term the ovipositor is named oviduct by him. I regret using the words in a different sense, but in the first instance it seems to me that his term is scarcely correct although a very natural error, he not having observed the central ovary; and, in the latter case, although the organ is unquestionably an oviduct, as far as the derivation of the word goes, yet it appears convenient to distinguish it by a name different from the duct between ovary and the vagina.

The **Vagina**, if this be a correct name for an organ which probably does not receive the male one, is a short but wide azygous duct into which the oviducts lead; it is manifestly the homologue of the ductus ejaculatorius, and is of similar consistency to the oviducts of which it forms the continuation. It appears to vary but little in the different species which I have

investigated, its office is to conduct the eggs from the oviducts to the commencement of the ovipositor. The egg does not remain here for any length of time, as it does in the oviducts.

The **Ovipositor**, or "external vagina" of Burmeister (in Insects), is an extremely beautiful organ, which varies considerably in proportion in different species. It is composed of a stout, brownish membrane, and is a long straight tube, which, when not in use, is invaginated like the finger of a tight glove when drawn off; in this way the distal half is withdrawn within the proximal. The whole apparatus is then withdrawn into the abdomen, and it lies, not exactly in the median line, but slightly slanting, and also sloping downward from the commencement, until it almost touches the genital plates, between which, when they are open, it emerges.

The membrane which forms the ovipositor is finely plicated by longitudinal folds and is also closely folded in a transverse direction, so that it seems like a ridge-and-furrow roof. This manifestly gives great power of distension. The plication is so fine that when viewed with an amplification of about fifty diameters the ovipositor seems iridescent, like a diatom seen with a power not sufficient to resolve it. The ovipositor is shown as retracted at Pl. G, figs. 3, 4, 10, *op*, as extended at Pl. G, figs. 7, 8, 11, *op*, and as partly extended at fig. 9, *op*.

Three distinct parts may generally, but not invariably, be observed in the ovipositor (Pl. G, figs. 8, 11), viz. the tube which is long and of almost equal diameter throughout, although slightly narrowing towards the distal end; the bulb, which is a globular or elliptical distension, not by any means always present, and the cusps (*c*), which are always three in number and are continuations of the edge of the bulb. Each cusp bears two or three stiff hairs or bristles on its outward side. The office of these cusps is evidently to seize the egg as it passes from the ovipositor, and hold it in position during deposition.

The ovipositor is sometimes comparatively short, as in *Damæus clavipes*, Pl. G, fig. 12, *op*; *Hermannia picea*, *H. reticulata*, &c. In other species, as *Notaspis lucorum*, Pl. G, fig. 11, *op*; it is longer than the whole length of the creature; when not in use it is considerably smaller in diameter than the eggs which have to pass through it.

The **Genital Suckers** are three pairs lying within the genital plates, and are in every way similar to those of the male (Pl. G, fig. 1, *gs*).

Nicolet figures the female reproductive organs of *Damæus geniculatus* more on the insect type than the crustacean, *i.e.* without the central ovary above named, treating my "oviduct" as the true secreting ovary, doubtless from not having found the other; he consequently treats what I call the ovipositor as the oviduct, he also gives the oviduct as laid out in a regular curve and not plicated; this is probably diagrammatic in order to display it; and he draws the eggs as following each other end to end at regular distances and gradually increasing in size like one of the ovarian tubes of an Insect. I have not found any specimen in this condition.

It is necessary here to notice a remarkable error as to the reproductive organs of *Oribatidæ*, for which Dujardin is responsible,* but which has somehow retained a place in some modern English works of authority.† The usually keen-sighted French naturalist started with the initial error that the *Oribatidæ* were wholly viviparous; having this idea in his mind he did not consider that they could have an ovipositor, and, as he found the organ, he took it to be the penis, a curious notion, for although that organ certainly attains a great length in some of the *Acarina*, *e.g. Proctophylodes* (*Dermaleichus*) *glandarinus* (Koch), yet a male organ longer than the body and thicker

* "Premier mémoire sur les Acariens," 'Ann. des Sci. Nat.,' 3me ser., t. iii, 1844, p. 5.

† Rymer Jones, 'Animal Kingdom,' 4th edit., p. 309, &c.

than the leg, would be an anomaly. Having settled this to his own satisfaction, Dujardin declared the opening below the hinder pair of plates to be the vulva, and concluded that the *Oribatidæ* were hermaphrodite; in this view Dujardin entirely forgot that the animals required an anus; and these errors still survive although Nicolet has exposed them.

Respiratory Organs.

Nicolet* describes the respiratory system of the *Oribatidæ* as consisting of two conspicuous stigmata, one on each side of the posterior portion of the cephalothorax, each stigma being funnel-shaped and opening by a minute circular aperture into an air-sac placed transversely in the body and bent upon itself in order to reach the stigma; and of four larger and and two smaller tracheæ on each side, the longer ones being distributed two to the dorsal and two to the ventral surface, and forming many convolutions; the two smaller being allotted to the cephalothorax. He states that this arrangement is general to all the *Oribatidæ* and only varies in other families of *Acarina*. I confess that until I began actually to dissect out the respiratory organs for the purpose of the present chapter, I never for an instant doubted the entire correctness of this description, and for a considerable time after my dissections had commenced I thought that I must have missed the arrangement described by the French naturalist, in consequence of the difficulty of the investigation; I found, however, that I could not, in any instance, trace the tracheæ up to the position described, nor could I find any air-sac in this place, from which they originated, although I found a sac or tube, apparently glandular, not far off, but with liquid contents instead of air, and not connected with the tracheæ. In the course of this investigation I have dissected, I

* Op. cit., p. 410.

should think, a hundred specimens belonging to numerous species. I find, with sincere regret, that although many parts of Nicolet's description are correct, yet I am not able to agree with him in other important particulars.

The breathing organs in adult *Oribatidæ* are usually, as Nicolet correctly says, tracheæ (I omit the air-sac question at present); these tracheæ are very long, and so delicate that the attempt to move or separate them, even with the finest badger hair, usually breaks them; and, as they are, as Nicolet says, considerably convoluted and are interlaced amongst the other organs, I have not always found it possible to ascertain with absolute certainty exactly how many there are. I incline to think that the number varies in different species. I have also found that instead of being similar in all species, the system differs materially.

To commence with the more ordinary arrangement, such as that found in *Oribata globula* (a very good species for seeing the tracheæ), *Oribata lapidaria*, *Damæus clavipes* and *D. geniculatus*, *Leiosoma palmicinctum*, *Notaspis bipilis*, &c., the main tracheæ are simple tubes, never anastomosing, and usually without any branches or dichotomous or other furcations or divisions, indeed, I doubt if such ever exist, except that some tracheæ are double or bi-forked almost from their commencement. These tubes are much convoluted or serpentine, and interlaced amongst the other organs. One large trachea on each side, which I call the "great dorsal" (Pl. D, figs. 3, 4, 5, *c*), winds above the alimentary canal, very close to the notogaster until near the posterior margin, when it takes a deeper course, following the alimentary canal, and becomes very difficult to trace. Another large trachea on each side, which I call the "great ventral" (same figs. *d*), passes in a serpentine line along the ventral surface, and is in connection with the sexual organs, winding about the oviduct and ovary in the female. Either one or two large tracheæ on each side proceed more along the lateral edge of the

abdomen between the two before described (Pl. D, figs. 4 and 5, *b*); there are also two or more shorter and finer unbranched tracheæ allotted to the cephalothorax on each side, one pair being distributed to the great muscles of the mandibles. The tracheæ are of almost even diameter throughout the principal part of their length; towards their ends they usually diminish and end in a point in the usual way; this is not, however, invariable, as the larger tracheæ, on the contrary, sometimes enlarge at their distal ends so as to form small bulbs or clubs (Pl. D, fig. 9).

The tracheæ above described approach very near to each other at their origin, and if one does not actually follow them to their starting-point (a matter of no slight difficulty), but is satisfied with their appearance after the removal of the notogaster or through transparent specimens, they unquestionably do look as if they were proceeding to the so-called stigmata (my pseudo-stigmata), which seem to be the natural places for them to go to. If, however, the adipose tissue and muscle be removed, and the tracheæ followed to their origins, it will be found that they turn away from the pseudo-stigmata and end separately in the acetabula of the legs; each trachea being often enlarged at the commencement so as to form a small air-sac, which either wraps round, or is attached to, the inner side of the acetabulum; this is seen in Pl. D, figs. 5, 6, 7, 8.

One main trachea only usually proceeds from the acetabulum of each leg of the third and fourth pairs; but in most cases (as *Damæus geniculatus*, *D. clavipes*, *Tegeocranus latus*, &c.) two proceed from each of those of the first and second pairs. In these cases they often join before reaching the stigma and form a very short joint trunk (Pl. D, fig. 17).

In consequence of the interlacing of the tracheæ among the organs it is far from easy to ascertain which trachea proceeds from each acetabulum, but by removing the notogaster, cutting the creature longi-

tudinally along the median line into two halves, removing the alimentary canal, and then syringing all fatty matter away from the acetabula, and thus floating out the tracheæ, I eventually succeeded in satisfying myself that in *Damæus geniculatus*, *D. clavipes*, and *Tegeocranus latus*, the great ventral trachea proceeds from the acetabulum of the fourth leg, the great dorsal from that of the third leg, the lateral trachea or tracheæ which wind among the organs and cross right over the body, and probably one of the cephalothoracic tracheæ from the acetabulum of the second leg, and the two small cephalothoracic tracheæ from that of the first. I believe this arrangement to be general in those species having tracheæ, except that those from the acetabula of the first and second legs may possibly not be always double, but of course I cannot speak with certainty of all species.

In other members of the family, such as *Nothrus theleproctus*, the respiratory system above described is greatly modified; tracheæ commence in the same places as in the species hitherto dealt with, but the nature of these air-vessels is very different; we no longer have long winding tracheæ of small diameter and very delicate walls, we have instead much shorter organs, thicker and less regular in form, and of a stouter and different texture: by this texture they may easily be recognised when the body is opened, as they have a thick silvery appearance not easy to describe. Under a low amplification they assume that slightly iridescent appearance characteristic of a lined object seen by a power insufficient to resolve it; using a higher power regular cross lines are strongly developed, and a still greater amplification will show an object thickly and regularly covered with small circular bosses, which will remind the observer of such a diatom as *Pleurosigma formosum*; this may, however, possibly be a deceptive appearance. The tracheæ or air-vessels proceeding from the acetabula in *Nothrus theleproctus* are very much shorter and thicker than in the form first

referred to, viz. that of *Oribata globula*, &c., and are not convoluted nor interlaced between the organs to the extent which we find in the longer and finer tracheæ of *Oribata*, *Damæus*, &c.; and at their extremity furthest from the stigma (the blind end), they are usually suddenly diminished in diameter, and carried on for a very short distance in a kind of point. In this form two air-vessels in the cephalothorax assume great importance and become the largest in the body; a short, wide trunk leads into a largish chamber, from which proceed two cæcal prolongations of unequal length (Pl. D, fig. 11); these share with the other tracheæ the characteristic of being short.

I have not found it easy to ascertain where the stigmata of these two tracheæ are; the acetabula of the first legs and the mouth-organs are very close together; the stigmata may be in the former, but these air-vessels seem very much as though they were proceeding to the latter, and it must be remembered that this is the position of the principal stigma or stigmata in *Cheyletus*,* *Trombidium*,† *Myobia*,‡ the *Hydrachnidæ*, &c.

It is very interesting to find this slightly developed and almost rudimentary condition, or absence, of the tracheæ in the genus *Nothrus* when we remember that the nymphs all through the family usually have the tracheæ in a rudimentary state; and that, in this genus, the want of hard chitinisation in the integument of the adults, their great resemblance to the nymphs, the carrying of the cast skins in some species, and other indications, seem to point to a creature whose adult form shows less progress from the nymphal stage than in any other genus.

* Fumose et Robin, "Mémoire Anatomique et Zoologique sur les Acariens des genres *Cheyletus*, &c.," 'Journal de l'Anat. et de la Physiol.' (Robin's), 1867, p. 563.

† Pagenstescher, 'Beiträge zur Anatomie der Milben,' Leipzig, 1860, Heft 1, p. 19; Henkin, op. cit.

‡ Claparède, "Studien an Acariden," 'Zeit. für wiss. Zool.,' 1868, pl. 37.

In *Hermannia arrecta* the cephalothoracic tracheæ are present, but very small and delicate. I have not succeeded in finding any abdominal tracheæ in this species; nor any tracheæ at all in the closely allied *Hermannia picea*, they may possibly be present, but too fine for me to detect.

In *Hoplophora* I have, subject to what is stated immediately below, failed to discover any tracheæ whatever; Claparède was greatly surprised at their absence.* He found, beneath Nicolet's stigma, which he calls "peritrema," three very minute sacs filled with air, which he says are not longer than the width of the stigma, and which in that case, from his drawing of the stigma, would not be above $\frac{1}{250}$ of a millimètre in length (his entire creature being over a millimètre). He considers these to be the entire respiratory arrangement, and to be modified tracheæ, equivalent to the so-called lungs of spiders, scorpions, &c., although he did not find any leaf-like arrangement within the sacs, or any blood-vascular system in connection with them. It must, however, be remembered that Claparède was doubtless relying upon the statement of Nicolet, whose book he quotes, that the tracheæ in other species arose from this so-called stigma.

In the English species of *Hoplophora* which I have dissected, I find these three sacs considerably longer than Claparède's description would lead us to suppose, and, indeed, his own figure of them is greatly in excess of the size given in his letter-press, so there may probably be a clerical error. In *Hoplophora magna* those I find have an S shape, but if straightened out they might probably be about $\frac{1}{8}$th of a millimètre; but this is a very large species, sometimes measuring $1\frac{1}{2}$ millimètres, whereas, in the species of *Oribatidæ* having ordinary tracheæ, these organs if straightened out would be twice or thrice the whole length of the creature, or even more, and the tracheæ are spread over the body, whereas these three sacs are quite

* "Studien an Acariden," 'Zeit. für wiss. Zool.,' 1868, p. 512.

parallel and close together during their whole length (Pl. D, fig. 14).

In *Nothrus palustris* (Pl. D, fig. 13) and *N. sylvestris* a somewhat similar arrangement exists; but here, instead of three S-shaped sacs of about $\frac{1}{8}$th of a millimètre, there is an almost globular bunch of nearly straight sacs, lying side by side, like a bunch of bananas; they measure about $\frac{1}{30}$th of a millimètre in length. (The length of *N. palustris* is about one millimètre.)

I have not yet discovered exactly similar organs in any other species which I have examined; but in *Nothrus theleproctus*, and other species, a small single sac containing air is actually enclosed in the pseudo-stigma itself. The parietes of all these sacs are clear, but very much thicker and stronger comparatively than the very delicate walls of the tracheæ of *Oribatidæ* usually are.

Claparède expresses his astonishment at the extremely rudimentary condition of these (so-called) respiratory organs in *Hoplophora*, and he well might do so. One naturally is diffident of questioning a conclusion on this subject arrived at by a man so extremely well acquainted with spider's lungs as Claparède was, but I cannot think that a sufficient respiratory system is shown here; it seems to me far more likely that these minute sacs are connected with the function of hearing or smell performed by these pseudo-stigmata, as suggested in the portion of this chapter on organs of special sense, where, therefore, I have thought it best to describe them. It strikes me that there are other means by which aeration could take place in *Hoplophora*. We know that in many soft-skinned *Acari*, as *Tyroglyphus*, *Sarcoptes*, *Dermaleichus*, &c., respiration is performed by the general body-surface without special organs; now, in *Hoplophora*, in consequence of the moveable ventral plate, so different to that of other *Oribatidæ*, its opening and closing must have a bellows-like action, and great

quantities of air must be drawn inside the carapace, and over the delicate lining membranes, through which aeration of the blood may well take place.

With regard to the more minute structure of the tracheæ in those species where they are fully developed, their walls are, as before stated, of extreme delicacy; this might be expected from the analogies of other *Arachnida*. I have not succeeded in seeing any spiral filament in them when they are in their natural state or *in sitû*, such as is so well known in the tracheæ of Insects; this, however, is due to the difficulties of observation in these very minute forms. We must remember that the existence of spiral structure even in the larger forms of spiders was denied by Menge,* and by Bergman and Leuckart;† also that Bertkau‡ denies its existence except in the single family of the *Attides*, and that MacLeod alone finds the spiral filiment in the intima of the tracheæ of all spiders.§

Turning to the *Acarina* a certain amount of spiral structure has been traced by Pagenstecher and Henkin in *Trombidium*, by Donnadieu in the closely allied *Tetranychus*,‖ and by Fumose and Robin in *Cheyletus*; in the two former families it was only found in the larger tracheæ. Nicolet simply says that the tissue of the tracheæ is the same as in insects, which can scarcely be considered quite correct.

I confess that I have always found it impossible to see any spiral structure in the unmutilated trachea, nor did teasing out, pressure, or breaking help me, and I had abandoned the hope of finding it, although I still thought it probably was there; at last, as a final effort,

* "Die Lebensweise der Arachniden," 'Neueste Schriften der naturforschenden Gesellschaft in Danzig,' Bd. 4, Heft 1, 1843.

† 'Vergleichende Anat. und Physiol.' Stuttgart, 1855.

‡ "Ueber die Respirations-Organe der Araneen," 'Archiv für Naturges.' 1872, pp. 208—233.

§ "La structure des trachées et la circulation péri-trachéene," 'Mémoire Concours Universitaire de 1878-9,' Bruxelles, 1880.

‖ 'Recherches pour servir à l'histoire des Tetranyques.' Lyons and Paris, 1875.

I tried immersing one of the larger tracheæ of *Damæus geniculatus* in glycerine jelly upon a glass slip, covering it with an ordinary glass microscopical cover, allowing it to cool, and then submitting it to pressure when it had the support of the jelly, and finally warming the jelly to allow the spiral to expand if it would, and once more letting it cool. The result of this was that the central part of the trachea separated into a broad spiral curl; a very fine external membrane appeared to have given way, and the whole interior to have broken up to form the curl; but no special filament had become detached, or was projecting from it. The trachea in this state is shown at Pl. D, fig. 10.

Before leaving the subject of the respiratory organs I will say a word more as to my not adopting the view held by Nicolet and Claparède, and generally received, that the two organs which look like stigmata on the cephalothorax really are so. One hesitates greatly to attack a conclusion supported by so much authority, but Nicolet is really the only observer who has ever investigated beyond the external appearance; Claparède only dissected *Hoplophora*, and there he did not find anything in connection with the so-called stigmata except the minute sacs referred to above. The matter is one of fact. In the tracheæ large enough to be traced I have not even succeeded in finding one attached to the so-called stigma, or proceeding from any air-sac attached to it; and I *have* found them arising from other places, as detailed above. Again, the pseudo-stigmata are quite as highly developed in the larvæ and nymphs as in the adults, although the tracheal system is rudimentary in the immature forms, as far as the observations of other arachnologists or of myself extend,—a circumstance (as to the absence of the tracheæ in immature forms) also observed by Pagenstecher in *Ixodes* and *Trombidium*, and by Kramer in *Gamasus*, *Tarsonemus*, &c. Again, the extremely small size or entire absence of the internal opening of the pseudo-stigma, which, if present, is almost or quite filled

by the peduncle of the so-called protecting hair (my pseudo-stigmatic organ), is against the hypothesis of their being true stigmata. For what it is worth it may also be mentioned that in *Pygmephorus spinosus*, a parasite of the mole, which possesses organs much resembling the pseudo-stigmata of the *Oribatidæ*, Dr. Kramer, its discoverer, could not trace any tracheæ to these organs,* although, doubtless, the weight of this is lessened by the fact that, in consequence of want of specimens for investigation, he was not able to trace the tracheæ to any stigma.

Excretory Glands.

The Super-coxal Glands.—I have said above that Nicolet describes an air-sac which I cannot find, but that I do find a sac, which I believe to be glandular, not far from Nicolet's position, although not attached at the point he names; this sac I call the "super-coxal gland," and I have very little doubt, from Nicolet's drawing, that it is the organ he saw and supposed to be connected with what he and others imagined to be the stigma. When the dorsal exoskeleton of the cephalothorax, and the adipose tissue which underlies it, have been removed, what appears to be the enlarged, blind end of a fine, colourless sac, may be seen on each side of the body, the seemingly blind end being nearest to the eye, the sac descending obliquely downward and slightly forward, and being attached near to the acetabulum of the coxa of the second leg. A closer examination shows that this is not the only attachment, but that the lower end is apparently bifurcated, and that the second branch is attached, or ends, much nearer to the centre of the body, and higher in level than the coxal branch. On dissecting out this sac, and carefully extending it, a

* "Zwei parasitische Milben des Maulwurfs." 'Archiv für naturges.' 43rd year (1877), vol. 1, p. 257.

matter by no means easy, it will be found that what seemed to be the blind end was not an end at all, but that the whole organ is an elongated, sausage-shaped sac, bent upon itself in the middle, and taking a single turn, so that the two halves cross; but for some distance the two limbs of the horse-shoe (if I may call them so) lie over each other, or are so closely pressed against one another as to appear one; it is only towards the ends that they stand free from each other when *in sitû*.

The general position of the organ in the body is shown at Pl. F, fig. 13, *sc*, and the organ unfolded and showing so much of its minuter structure as I am acquainted with at Pl. F, fig. 12.

The walls of the sac are colourless but highly granular, apparently of considerable thickness, and it appears to me decidedly glandular. Within the sac, *i.e.* either on its inside surface or in the substance of the walls, and near to the centre (long axis) of the sac, is a double row of highly refractive points arranged at regular distances, those of the two rows not being opposite but alternate. A fine, distinct, double line may be seen uniting the alternate points so as to form a double zig-zag all along the organ, the refracting points being slight prolongations of the zig-zags. Three possible explanations of this structure seem to offer themselves. 1st. That the double lines are tubules, as in the nephridia of Vermes. 2nd. That the space between the fine lines is really the zig-zag lumen of the sac, possibly running between cells projecting alternately from the opposite walls and having a cuticularisation at the refractive points. 3rd. That the whole (zig-zag and points) is a cuticular strengthening on the interior wall of the sac, the cuticularisation being greatest at the refractive points, which may be intercellular.

Connected with this tube is a globular body which has thick, but less granular walls, and which is probably hollow; both the gland and this body when

pressed discharge liquid. There is not any sign of air in either.

What is the office of this organ? I cannot pretend to do much more than guess; but, if a suggestion be allowable, I would point to the nephridia (segmental organs) in *Vermes* and the green gland in *Astacus* and other *Crustacea*, and the coxal glands in *Scorpio* and *Limulus* as those where the analogy may be sought. The resemblance to the first in particular is very considerable in the general form of the organ, and to a lesser extent in the minuter structure;* if the double lines be tubules they would be analogous to those in the nephridia. The sac above described (super-coxal gland) would correspond with the gland in the nephridium and the globular body with the vesicle.

The position would seem to correspond fairly with that of the green gland and the coxal glands, in the former of which Will and Gorup-Besanez say that they found guanin;† and Huxley says that, if this be so, there can be little doubt that it represents the kidney, and its secretion the urinary fluid;‡ while Ray Lankester is inclined to look on the latter as homologous with the nephridia.§

I cannot say that I have succeeded in finding any actual opening of the super-coxal gland to the exterior, or of the second branch to the interior, but the extremely small size of the creatures and of the gland, and the position of the latter, make it very difficult; and, indeed, Professor Lankester does not seem as yet to have been more successful in this particular respect with the larger forms which he has been dealing with.

The Expulsory Vesicles.—In *Hoplophora magna* above and a little behind the super-coxal glands, I find, on each side of the body, a long pyriform sac (Pl. F, fig. 17, *ex. v*), having the open end discharging

* See A. G. Bourne, "On the Structure of the Nephridia of the Medicinal Leech," 'Qrly. Jour. Microsc. Sci.,' 1880, pp. 283-302.

† 'Gelehrte Anzeigen d. k. Baierischen Akad.,' No. 233, 1848.

‡ 'The Crayfish,' London, 1880, p. 83.

§ 'Proc. Roy. Soc.,' xxxiv, 1882, pp. 95-101.

outside the body. This vesicle has walls less finely granular than the glands in *Leiosoma* (*Cepheus*), &c., but very glandular, and taking stain deeply. I have not found in it either the refractive points or the zig-zag markings; it is not doubled on itself nor twisted.

In *Hermannia arrecta* there is a chitinous projection on each side of the abdomen, which Nicolet calls a "stigmatiform tubercle." He does not offer any suggestion as to its office or its connection with any internal organ; in reality, however, this "tubercle" is tubular (Pl. F, fig. 15), and immediately within the chitinous exo-skeleton is a considerable-sized, membranous, elliptical sac, discharging to the exterior through the chitinous tube, to which it has a very small mouth. The membrane composing this sac is clear, and does not take stain readily.

In *Hermannia picea* and *H. bistriata* there is not any chitinous projection, but there is a minute foramen in the chitin of the notogaster; rather more dorsal in position than the projection in *H. arrecta*, there is a sac, somewhat similar to that of *arrecta*, but smaller in proportion and rounder, discharging to the exterior through this foramen. In *Nothrus palustris*, *N. spiniger*, and *N. sylvestris*, a somewhat similar sac is found on each side near the anal end of the notogaster, close to the terminal apophysis. I have not hitherto detected these sacs in the adults of any other species, but they may quite possibly exist, and might be found if one had the time to search for them; and analogous organs occur in several of the nymphs, as *Oribata lapidaria* (Pl. V, fig. 2), *Oribata setosa* (Pl. VII, fig. 4), *Oribata orbicularis* (Pl. XI, fig. 12), &c. In these instances the sac is situated a little further back than in *H. arrecta*, and discharges to the exterior by a small pore or foramen, which in *O. lapidaria* is surrounded by a black ring.

These sacs I propose to call the "expulsory vesicles." They all contain liquid, which may be driven through the foramen, or tube, by pressing the vesicle. In the adults this liquid is of a yellow colour, does not mix

readily with water, but floats and spreads out on its surface like oil, it is highly refractive, and does not dry for a long time if placed on a glass slip. I did not succeed in tracing its chemical composition.

These expulsory vesicles appear to be similar to those described and figured by Claparède in *Hypopus Dujardinii* (so called); he considers them to be excretory organs.

The Question of Circulation.

In one of his papers on the *Gamasidæ** Dr. Kramer says, under the head "Organ of Circulation," and as the last paragraph of the anatomy, "In *Gamasus* there exists a briskly-pulsating heart, placed in the hindermost third of the abdomen. As in most species the hard dorsal shield renders observation of the internal organs impossible, it is only the immature specimens, or those which have just undergone a change of skin, which are fit for observations of the heart; in these, however, it can easily and certainly be recognised; its movements are, of course, most distinct from those of the excretory glands, and, moreover, the position immediately under the skin corresponds with that of similar organs in other Articulata."

One is, of course, liable to overlook records, particularly if short; a really exhaustive search is almost impossible, but, as far as I am aware, this is the only instance in which any biologist has stated that he has detected a heart in any of the *Acarina*. It is to be regretted that Dr. Kramer did not give more detail; still every observation of his is worthy of the gravest consideration.

It happens curiously enough that while Kramer was writing this paper an equally able acarologist, P. Mégnin, was engaged on precisely the same subject,

* "Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden," 'Archiv für Naturges.,' 1876, p. 65.

neither knowing of the other's investigations; the two papers appeared about the same time, and they are directly contradictory on numerous points, but the present is one of the most striking. Mégnin says, in his chapter on digestion and circulation, under the head of "Circulatory Arrangements,"* "It is not without design that we have included the digestive and circulatory functions in the same chapter. In effect these functions are so connected that there is, so to speak, only one apparatus for the two, the diverticula of the stomach have the office of conveying the nutritive fluids to the different parts of the body, so that the digestive organs of *Gamasus* deserve the name of gastro-vascular equally well with that of the planarian worms to which it was given by Quatrefages. Outside these tubes, from which it escapes by compression or exosmose, the nutritive liquid is in direct contact with the muscles, tracheæ, and other organs, which it bathes, and presents no other movements than certain partial and irregular undulations provoked by muscular contractions. The circulation is therefore purely lacunar, as in the lower Molluscoidea, such as the Ascidians; and there does not exist any organ similar to the heart or dorsal vessel of Insects and of the higher *Arachnida*, destined, by its regularly repeated contractions, to give rise to an incessant circulatory movement of the liquid."

If we look to the analogies of other families of *Acarina*, Claparède, referring to *Atax*† (a genus of *Hydrachnidæ*), says: "In *Atax*, as in the *Acarina* generally, there is not a trace of heart or vessels, the blood flows round the organs and supplies their tissues."

Mégnin, again, referring to the genus *Sarcoptes*, &c. (the itch-mites), says:‡ "The contractions of the

* "Mém. sur l'organization et la distribution zool. des acariens de la famille des Gamasidés," 'Journ. de l'anat. et de la physiol.' (Robin's), May, 1876, p. 316.

† "Studien an Acariden," 'Zeit. für Wiss. Zool.,' 1868, p. 478.

‡ "Monographie de la tribu des sarcoptides psoriques," 'Rev. et Mag. de Zool.,' 1877, p. 158.

muscles contained in the members or the rostrum impart a certain very irregular fluctuation to the circulating liquid; these are the only movements which we have been able to observe in it; for the *Acarina* do not possess any trace of the dorsal vessel or heart of true Insects."

Dr. Haller (of Bern), whose attention had been specially called to Kramer's statement, says,* referring to *Tyroglyphus*, "A heart, such as Kramer observed in *Gamasus*, is entirely absent, at least I have always sought for it in vain."

Nicolet, speaking of the *Oribatidæ*, says: "The dorsal vessel has always completely escaped me."

In addition to the opinions above cited, we have the fact that such excellent anatomists as Croneberg, Pagenstecher, Robin, Donnadieu, &c., do not make any mention whatever of a heart or any blood-circulating vessels.

I have not myself paid attention to the subject in *Gamasus*, but in the *Oribatidæ* I have done my best to discover anything of the kind, both by dissecting numerous species and by observing the living creatures in immature stages, and the adult when lately emerged from the nymphal skin, at both which periods many species are fairly transparent, and I have utterly failed to discover any trace whatever of a heart or special blood-vessels. It appears to me that the nutritive fluids escape from the alimentary canal, by exosmosis, or otherwise, as Mégnin says, into the general body-cavity, where they bathe the muscles and other organs, and the contractions of the great muscles of the legs and mandibles, and also the movements of the alimentary canal, keep the fluid in tolerably constant, but very irregular and uncertain, motion, during which it washes round the long tracheæ and becomes aerated; but it has not, as far as I can discover, any regular circulation. It is only during long periods of

* "Zur Kenntniss der Tyroglyphen und Verwandten," 'Zeit. für wiss. Zool.,' 1879, 175.

inaction that any special provision seems to be made for keeping the blood or nutritive liquid in movement. If one of the more transparent nymphs be observed during the latter part of the long inert period which precedes the change from nymph to adult, it may often be seen that a certain very slow, but rythmic movement is taking place, which may be best traced by the two conspicuous preventricular glands which are seated one on each side of the entrance of the œsophagus into the ventriculus. It will be seen that these glands are very slowly, almost imperceptibly, advanced to a certain point and then suddenly retracted, to be again advanced with equal slowness and again retracted, and so on. I have also occasionally observed something similar when a creature which is not inert has been quite still for some time. It seems possible that this may arise from the muscles of the alimentary canal assuming the office of keeping the fluids in the small amount of motion requisite, when those of the legs and mandibles are not incidentally performing it.

The Nervous System.

I have little to say on this subject as I have not as yet been able to trace the nerves in a manner sufficiently satisfactory to myself to induce me to put suggestions forward as a guide to others; the great main ganglion, however, is not difficult to trace; as in most of the *Acarina* it is a single, very large, usually elliptical, ganglion, which seems to serve cephalothorax and abdomen, and is placed above the œsophagus near to its junction with the ventriculus, and consequently very close to the pre-ventricular glands (Pl. D, fig. 12). In many species this ganglion, or commissures from it, fold over, and pass downward at the sides of the œsophagus, and it is, I think, sometimes thus connected with a very much smaller sub-œsophageal ganglion. The supra-œsophageal ganglion is composed of ganglion cells,

which, in *Tegeocranus coriaceus*, are about $\frac{1}{25000}$ mm. in diameter. The interior of the mass seems to be the true ganglion and to be composed of several lobes, apparently five in *Nothrus theleproctus*; this part stains deeply with the chloride of gold, but is enveloped in a thick covering of a more structureless nature, which scarcely stains at all with that reagent, and which, in *Trombidium*, where it also occurs, Henkin calls the "Hulle." I propose to distinguish it as the peri-encephalon, although possibly the œsophageal ganglion is not strictly a brain.

Organs of Special Sense.

Touch.—The mother sense, as it has been called, is highly developed in the *Oribatidæ*, it is the leading sense, by which these minute creatures guide their movements and protect themselves from danger. It may well be asked wherein does this delicate perception reside in beings whose hard and brittle, chitinous cuticle promises but little sensibility; the answer is not difficult. It is in the numerous long hairs and setæ which are found in different parts of the body, that the tactile sense is chiefly specialised. We do not find in the *Oribatidæ*, as we do in the *Chyletidæ* and *Gamasidæ*, that the first pair of legs practically have become organs of touch not locomotion, and are kept constantly trembling in the air. Among the *Oribatidæ*, on the contrary, the first pair are true walking legs, but from the lower part of the tibia of each leg of this pair there invariably springs a long setiform hair, which stands forward horizontally so as to project in front of the rostrum and give warning of the approach to any solid object. These hairs, which I call the "tactile hairs," will be found in every drawing of a first leg in this work. It is not, however, the first legs alone that are thus provided; similar tactile hairs, not so large in proportion, are frequently, although not invariably, found upon the

tibiæ of some or all of the other legs, more especially those of the second pair; but even those of the third and fourth pairs frequently have them developed to some extent, although the first pair are always the largest. These hairs are highly sensitive; if one of them be touched when the creature is moving its course is arrested instantly; in addition to these there are numerous other hairs upon the tarsi and tibiæ, which probably have more or less of the tactile sense allotted to them.

The hairs on the tibiæ are not the only ones which serve as tactile organs; those on the notogaster, which usually stand upright; those terminating the lamellæ, usually horizontal; and those upon the ventral surface, usually directed perpendicularly downward, are very sensitive to touch, and surround their possessor with a tactile chevaux-de-frise as efficient as a cat's whiskers.

Anyone who accidentally puts one of the *Oribatidæ* living upon a warm slide will soon see that the tarsi are sensitive to touch; probably this chiefly resides in the hairs with which they are clothed.

Sight.—The *Oribatidæ* do not possess any eyes, as far as can be judged from investigations made up to the present time; this is not singular amongst the *Acarina*; the *Gamasidæ*, the *Sarcoptidæ*, the *Tyroglyphidæ*, the *Cheyletidæ*, and many others are devoid of any known eyes, but this does not entirely prevent them from having some dull sense of vision. The *Oribatidæ* have a quick appreciation of the difference between light and darkness, and they decidedly prefer the latter, indeed, so strong is the preference that it makes them very difficult to observe; it would seem as though the cephalothorax were more sensitive to light than the abdomen, for when drawing from the living specimens it is difficult to get sufficient light upon the cephalothorax, as the animal, unless fixed down so tightly that it is injured, always manages to turn round so as to get its cephalothorax away from

the light, *i.e.* pointing in an opposite direction. There would appear, moreover, to be some visual perception superior to that of a mere appreciation of light and darkness, for if the creatures be placed in the sun and there be some shadow near, they will not go wandering vaguely about until they accidentally meet the shadow, on the contrary, they make straight for it, and take up their quarters there without delay.

Taste is supposed to be seated in the palpi, which are very active organs, constantly moving and touching the ground, &c., as the creature walks; they may possibly possess some tactile office as well as the gustatory, but food certainly seems to be examined by them, they do not appear to differ essentially from the maxillary palpi of insects.

Hearing or Smell.—I am not aware that there are any recorded observations upon these senses in the *Oribatidæ* except a few remarks by myself.

I have before explained that at each side of the base of the cephalothorax in all members of the family, both in the adult and immature condition, there exists a chitinous, tubular projection. This, except in one or two species, is very conspicuous, and externally presents a large opening, but being funnel-shaped inside, the calibre diminishes until the lower internal diameter is excessively minute, and this small opening, if existing, is wholly or chiefly filled by the peduncle of an organ which projects exteriorly from the tube. The tube is the stigma of former acarologists, and the projecting organ is Nicolet's protecting hair. I must confess that the tube looks excessively like a stigma, and that, like others, I supposed it to be one, until I came to dissect. In the portion of this chapter on respiratory organs I have called it the "pseudo-stigma," and given my reasons for not considering it the true stigma, which are, *inter alia*, that the great tracheæ do not end there, but end somewhere else, and that the organ is quite as fully developed in the larvæ and nymphs, which, as far as I know, do not possess tracheæ,

as in the adults which do. What, then, is the organ in question? I will first consider the so-called protecting hairs. When one finds in nature an organ having a special function allotted to it, one usually finds it eminently fitted to perform that function; are these fitted to protect a stigma? I cannot think so, they vary in form, being frequently clavate (*Pelops lævigatus*, *Oribata orbicularis*, &c.); sometimes almost globular, on very short peduncles (*Cepheus ocellatus*); sometimes broadly flabellate (*Notaspis licnophorus*, *Scutovertex maculatus*, &c.); oftenest with long, thin peduncles and enlarged ends of various forms (*Serrarius microcephalus*, *Tegeocranus coriaceus*, *Oribata alata*, &c.); sometimes setiform (*Notaspis bipilis*); sometimes even pectinated (*Hypochthonius*); but whatever the shape be they are almost always fleshy organs, having the club-like ends, where those exist, composed of large clear cells, and having a well-marked hollow space in the centre of the club. They have all the appearance of sense-organs, and it is usually impossible that they could under any circumstances close the entrance of the supposed stigmata or prevent foreign bodies from entering, while being soft and flexible they cannot give the protection of another kind which hard spines or ridges might afford. It is very difficult to see in what way they can be protective. The peduncle is usually not straight, but turns both before reaching the pseudo-stigma and within it, so as to assume almost an S-shape (Pl. A, fig. 12; Pl. II, fig. 12). The clubbed end of the organ is generally provided with delicate hairs, standing straight outwards, which seem as though they were of a sensory nature; there is also an appearance as though fine, short hairs projected into the hollow central space, and if so they may well have an auditory character. Again, looking to the so-called stigma we find that it is not straight but more or less twisted, and often with fine lamellar ridges on the inside, so that it would seem as if vibrating surface were required; again, as before

stated, Claparède found some minute sacs, he says not longer than the diameter of the pseudo-stigma, in connection with the internal opening of that organ in *Hoplophora*; and although those I find in the position he names are considerably larger than the size he gives, yet they would hardly seem sufficient for respiration; they might, however, serve some sensory purpose.

They consist of three ɔ-shaped sacs, lying close together and quite parallel, almost touching all along their course. In *H. magna* (a species about $1\frac{1}{2}$ mm. long) they would be about one eighth of a millimètre if straightened out; in such other English species of the same genus as I have dissected they are rather less in proportion but similar in formation. They are of about even diameter throughout, and certainly end blindly at the inner end, and I think at the outer also; but this is very difficult to ascertain. There are not any tracheæ nor other air-passages in connection with them. They are drawn at Pl. D, fig. 14.

In *Nothrus palustris* and *N. sylvestris* the three sacs of *Hoplophora* are replaced by an almost globular bunch of over twenty nearly straight similar sacs, not above $\frac{1}{30}$th of a millimètre in length, and all quite close together (Pl. D, fig. 13); these seem to end within the pseudo-stigma in a small brown striated mass, which has an extremely minute pore in its centre, surrounded by a thickened ring.

In the other species which I have examined I have not hitherto detected any similar sacs; but in *Nothrus theleproctus*, and some other species, there is a single sac, very short, but of larger diameter than in those above named, lying actually within the inner part of the pseudo-stigma, and shut off by the inner chitinous wall of that organ from all communication with the interior of the body; one of these last-named sacs is shown at Pl. D, fig. 15. The walls of all these sacs are clear, but very thick and compact; they are usually smooth, but in *N. palustris* are sculptured. The pseudo-stigmatic organ usually leads up to them.

We can only judge of the senses by human analogy, and it seems most natural to suppose hearing or smell (I incline to the former) to be resident in these organs; the existence of tracheal vesicles in the supposed hearing organs of many of the *Insecta* must not be forgotten, but until nerve branches can be traced to them it must remain more or less doubtful whether they be sense organs.

PART II.

DESCRIPTION OF GENERA AND SPECIES.

PRELIMINARY OBSERVATIONS.

TO BE READ BY EVERYONE USING THE BOOK FOR IDENTIFYING SPECIMENS.

In order to enable naturalists to identify readily by the following descriptions and figures it is absolutely necessary to bear in mind the latter part of these observations, pp. 195—200; that is to say, those subsequent to the statement of the manner in which the drawings and descriptions have been prepared; a subject upon which I think it will be useful to say a few words.

Firstly, all the drawings of whole creatures have been, where possible, drawn from living specimens, and with regard to the larvæ and nymphs every figure in the book has been drawn from the life. This indeed is almost a necessity, because in most instances the immature forms have the cuticle only slightly chitinised, and therefore often collapse after death; or, if preserved in a medium which prevents this, the mere relaxation or stiffening of the muscles and tissues, as the case may be, after death, alters the form considerably. Even in the case of the adults it is better to draw from the living creature; as not only is the general appearance and texture far more reliable, but

also a great deal of information as to the form and articulation of the legs is obtained by seeing them in movement, and it is only in life that the true position of the palpi is seen at all. While, however, I have drawn from the life in every possible instance, I have also endeavoured, in the case of adults, always to have a specimen, well mounted in balsam without pressure, by my side under a second microscope for constant reference. The advantage of this is that many points of form, especially as to the insertion of the legs, and the form and arrangement of the tectopedia, can be well seen in the mounted specimen, which has been artificially cleared, but would probably remain unknown if living specimens only were used. This applies especially to the case of creatures which are very small, and are also very black and of a rough texture, as, for instance, *Tegeocranus coriaceus*; it is scarcely possible to concentrate sufficient light upon such an object to enable the observer to see it clearly under a sufficiently high power. It must be remembered, however, that the texture cannot ever be properly seen after the specimen has been treated with reagents, and also that the legs of dead unmounted specimens close up.

In the case of the adults of very rare species, or those where I have only one or two specimens, probably mounted long before I commenced this book, I have, of course, been forced to draw from the preparations, assisted by my recollection of what they were like when living; this applies to *Cepheus bifidatus* and *Tegeocranus femoralis* in this volume.

Having decided to draw from the life, the next question was how to do so. I do not think that the camera lucida is calculated to produce a good result in such a case; firstly, because in order to draw it at all by that mode the creature must be fixed so tightly, in the compressorium or otherwise, that it cannot move. This I always found produced either fracture or distortion; moreover, in creatures having a consider-

able proportionate thickness, the whole is not in focus at once, and, if focussing take place, the drawing is rendered incorrect. Again, legs cannot be fixed except by being gummed, a process not always possible with these very minute *Acarina*, and which, even when possible, is unsatisfactory, and produces deceptive positions. The process which I found most to my own taste, and which I have adopted, is that of dropping a circular piece of glass, ruled into fine squares, on to the diaphragm between the field-glass and eye-glass of the eye-piece, and having the paper on which the drawing was made ruled into squares of moderate size, and drawing square for square. In my opinion I can produce more correct results by this method than by the use of the camera for such objects as those spoken of above.

The next question is the mode of fixing the live creature, which is very small, often somewhat globular, slippery, and strong, and excessively brittle, so as to be able to draw it at all, without breaking or distorting it. I did not find the compressorium or live-box answer the purpose; they distorted the object, they pressed the hairs on the back down quite flat, and, unless the animal were exactly in the middle of the compressorium, sufficiently high powers could not always be used, and it is quite difficult enough to get the object into exactly the right position for drawing without having also to attend to centreing; moreover, the smallest lateral movement of the free arm of the compressorium would destroy the creature.

The plan which I hit upon to avoid these difficulties was very homely. I used a Stephenson's binocular microscope with a large plain stage; this instrument has the great advantage that the stage is horizontal while the tubes are inclined at a convenient angle, and thus the draughtsman may use an arrangement which would slip on a sloping stage, and at the same time need not keep his head bent for hours over a vertical tube. Upon the stage of the microscope I arranged an ordinary 3×1 inch slip of glass, upon which I

placed the creature, and upon the creature I laid, as gently as possible, a good-sized ordinary cover-glass, not fixing it at all; this rested on the back of the Acarid. If the cover-glass tilted too much a small scrap of paper, under one or both sides of it, cured this difficulty, and still left the cover resting on the back. Thus I gave my "artist's model" what was, to him, a very heavy weight to carry, and, although he could still walk about a little, it was so very slowly that I did not find any great difficulty in drawing from him.

The outlines of parts of the various creatures have mostly been drawn with the camera from dissections. I have sometimes used the ordinary Wollaston form, but more frequently the Zeiss two-prism camera, which I prefer, as the position of the microscope is not so rigidly confined, and the position of the paper is more convenient.

When I first thought of writing this book my idea was to draw all figures of adults to one scale, and all parts to another. I soon found with regret that I could not carry out this good intention. The *Oribatidæ* vary in size very much, some being five or six times (linear) as large as others. The small species are often the most elaborate, and the most characteristic parts are often a very small proportion of the body. If, therefore, all figures of whole creatures were drawn to one scale either some figures would be unnecessarily large, and space and money would be wasted, or else the lesser species would be figured on so small a scale that the drawings would be practically useless. The same remarks apply to the parts, and even the adoption of two scales for each would not have entirely removed the difficulty. I therefore abandoned the idea of uniformity of scale, and used, in each instance, what happened to be most convenient; but the scale of each figure is given in the explanation of the plate, and the real average length of each adult is given below the figure in decimals of

a millimètre. It would be useless to give the sizes or amplifications of nymphs or larvæ as this depends on age, but the mature nymph is almost always a trifle smaller than the perfect Acarid.

I have endeavoured to give a figure of the adult form of each species, and of the nymph or larva, where known to me, except in a few instances where the resemblance to some other species, already figured, was so close that the drawings would have appeared precisely similar, and I thought it better to point out in words the difference which exists.

A description of each species is given which I hope may prove sufficient for identification. A statement of the characteristics of each genus is also, of course, added, to the best of my ability; and at the end of the account of each genus is a table to assist in the identification of such British species as are known to me; these tables are not intended as classifications, but simply as aids in identification. I must repeat that I cannot hope or expect that my own almost unaided labours during the scanty leisure of a few years have succeeded in tracing all, or nearly all, the British species; the discovery of new ones may render the tables less easy to use.

I now wish to draw attention to the following observations relative to identification. In the first place I may repeat what has been said before, viz. that in species derived from Koch there is usually not any absolute certainty that the British specimens are Koch's species, because that writer's descriptions and figures are not exact enough to admit of it; but whenever they tallied fairly well with the creature I found I have inclined to allotting them to Koch's species, rather than to creating new ones; at the same time it is quite possible that I have missed one or two of Koch's species, as identifying by his book certainly presents great difficulties.

Again, with regard to Nicolet's descriptions and figures, I have seldom found the English specimens

agree exactly with them. I have disregarded these trifling differences, looking upon them as local variations; otherwise I might have discarded the whole of Nicolet's species and made others.

With regard to my own descriptions and figures, the reader must remember that the different specimens of the same species, or what I believe to be the same species, vary a good deal. They vary, firstly and principally, in size; this variation is very considerable, but probably not more than is found in many species of *Lepidoptera*. The large specimens are often found in different localities from the small specimens, although sometimes both are found together. It occasionally appears as if only large and small specimens were found, without intermediate sizes. As the difference does not appear to be sexual, it certainly, in these cases, gives rise to a suspicion of distinct species; but, if we come to the conclusion of allowing them as distinct, we shall usually find our calculations upset by the discovery of intermediate sizes elsewhere. Therefore, although size is undoubtedly an element for consideration where there are other things as well to show that there is a distinct species, yet I have disregarded it for that purpose where it stands alone. The variation in size is remarkable in *Pelops acromios*, *P. lævigatus*, *Oribata alata*, *Oribata punctata*, *O. mucronata*, *O. setosa*, *Leiosoma* (*Cepheus*) *simile*, *Cepheus tegeocranus*, &c.

It may reasonably be said that if the size vary so much it is foolish to give sizes as minutely as is done in the measurements at the heads of the following descriptions; but it will probably be seen on reflection that this is hardly the case, because, although the size of the whole creature may vary, yet the proportionate sizes, *i.e.* the comparative proportions of the length, breadth, and length of the respective legs in the adults vary very little, and these proportions form a very good mode of identification. It is obvious that they could not be given if a type length for each species

were not fixed on; I have, therefore, in each case, selected what seems to me to be the commonest length as a basis for comparison, and, moreover, it will, in the majority of cases, be found about correct.

All measurements are given in decimals of a millimètre, but a table is given at the end of these observations (p. 201) to facilitate their conversion into inches by those desirous of doing so.

Although it is stated above that the form does not vary much, yet it does vary a little, chiefly in the length of the abdomen, and the roundness or pointedness of its posterior margin. This variation is considerable in such species as *Eremæus oblongus*, *Notaspis lucorum*, &c.

The colour of the adults also varies a good deal, that is to say, not the sort of colour, but its intensity, some specimens being much lighter than others; this is especially the case with *Oribata alata*, *Oribata globula*, &c. I have sometimes fancied that the males are the lighter. Almost all are light when they first emerge from the nymphal skin.

Next, it must be remembered that the figures, particularly of adults, are to a great extent diagrammatic in position, living creatures do not usually assume the "spread-eagle" posture in which it is convenient to draw them in order to display the legs; in reality, with the exception of such long-legged things as the larger members of the genus *Damæus*, the tibiæ and tarsi are usually held perpendicularly, by which means the body of the creature is kept off the ground, and, when looking from the dorsal aspect, the genual is the last joint seen, but were they to be drawn thus the form of the leg would be lost, and it is often valuable for identification.

The forms of the pseudo-stigmatic organs and of the inter-lamellar hairs vary very little, if at all, in the same species, *and constitute one of the best and safest modes of identification of species*; but the student must be careful to remember that the apparent form depends

frequently very much upon the aspect from which they are seen; thus spatulate stigmatic organs appear filiform if seen on edge, clavate and pyriform organs appear globular if standing perpendicularly and seen from above, recurved organs do not always show the curvature unless seen from the side.

The hairs of many species are very caducous; it is rare to catch a specimen which has not lost some of them.

It is often difficult to see whether there are three ungues or one to each tarsus; if the specimen appear monodactyle every leg should be examined, one should not be trusted to, as thin lateral ungues sometimes lie close against the large central unguis and are not seen; on the other hand, two curved hairs often simulate the lateral ungues, so as to make a monodactyle specimen appear tridactyle if seen from above only.

The puncturing of the dorsal surface in such species as *Oribata punctata*, *Notaspis lucorum*, and numerous others, and the dotting or reticulation in other species is much too fine to be properly represented by lithography, the drawings can only indicate the class of thing, they cannot equal nature in the fineness and clearness of this work. The same remark applies to the fine hairs on the tarsi, &c., which are often far finer and more numerous in nature than it is possible to depict in lithography.

The apparent form of the joints of the legs depends on the position from which they are seen quite as much as that of the stigmatic organs; this is well seen in the coxæ and femora of the genus *Oribata*.

The rostrum will, of course, look shorter or longer from the dorsal aspect, according as it is more or less depressed. Most of the creatures have the power of raising or lowering it a little.

If the mandibles, or either of them, be at all protruded this gives the rostrum the effect of being blunter anteriorly than it really is; the mandibles in some species are capable of considerable projection.

The apparent shape of the *Pterogasterinæ* depends greatly upon the degree to which the pteromorphæ are expanded; this not only alters the width, but also it often happens that when the pteromorphæ are pressed to the body their edges appear continuous with the line of the abdomen, whereas when raised they present a sharp angle with the abdominal line.

Creatures which carry a coating of dirt, as *Nothrus horridus*, *N. spiniger*, and others, look very different according to the amount of the dirt carried at the moment. The dirt adheres even to the hairs, and sometimes when two hairs are thick and situated close together the dirt forms a sort of shelf between the two.

The nymphs of course vary greatly in size according to age. It is not possible to ascertain the age excepting in the instance of nymphs which carry the cast notogastral skins. These show immediately how many ecdyses the specimen has undergone.

The nymphs also vary considerably in colour from age, the young specimens being usually the lighter ones, and this is observable in the legs as well as the bodies; and also in different specimens irrespective of age. Reds and pinks vary to browns, as in *Pelops acromios*, *Oribata lapidaria*, &c. Light browns vary to dark browns, as in *Oribata punctata*, *Scutovertex sculptus*, &c., blue-greys vary to yellow-greys, &c. The colour of the food also shows through the dorsal skin in most instances, and of course the colour and form of the markings so produced varies constantly.

It must also be remembered that the nymphs present a very different form and appearance during the inert period; the body is then apt to lengthen considerably, which chiefly results from the fact that the base of the cephalothorax, in the nymphs of most species, is usually more or less sunk in the abdomen, but during the inert period this seems to draw out and extend. In the instances of *Oribata mollicomus* and *Notaspis bipilis* the nymph is drawn both in the

active and inert stages, so as to show the difference. During the inert stage, moreover, the dorsal surface is apt to puff up and become more arched, the wrinkles or folds in the skin, where they exist, usually become obliterated, and so do many of the markings. The nymph of *Oribata gracilis* is drawn from an inert specimen.

The form of the nymphs is usually rather narrower and flatter when young than when older, but this is not invariable.

It must be borne in mind that the colouring of the plates is only an indication, not an exact copy, of nature, because it would have been too expensive to print in a sufficient number of colours really to have reproduced my drawings, and it was thought better to put up with this rather than adopt the less certain plan of colouring by hand, a process in which it is too expensive to put in much detail.

Finally, everything should be seen by reflected as well as transmitted light, and from the side as well as the dorsal aspect if possible.

In the outline drawings of parts of the creatures most of the hairs have been omitted for the sake of clearness, as they obscure the articulations, &c., only the chief hairs are shown.

At the end of the plates illustrating the species will be found some outline drawings or diagrams (Plates XXIII, XXIV) of the forms of the cephalothorax and its lamellar and other appendages in species which are more or less difficult to identify, such as those of the genus *Oribata*; I hope that these may be found useful. A drawing of a labium and surrounding parts is also added for each genus.

In the authorities given for the synonyms—

"Can. e Fan." means G. Canestrini and F. Fanzago's 'Intorno agli acari Italiani.' Atti del R. Instituto Veneto di Sci., &c. Venice, 1877.

"Haller" means Dr. G. Haller's "Beitrag zur Kenntniss der Milbenfauna Württembergs," 'Jahresheften d. Ver. f. vaterl. Naturkunde in Württ.,' 1882.

"Herm." means J. F. Hermann's "Mémoire aptérologique." Strasbourg, 1804.

"Koch" means C. L. Koch's "Deutschland's Crustaceen, Miriapoden und Arachniden." Regensburg, 1834-9; forming Hefts 1 to 40 of Heinrich Schäfer's 'German Insects.'

"Nic." means M. H. Nicolet's "Histoire naturelle des Acariens qui se trouvent aux environs de Paris." 'Archives du Muséum,' t. vii, 1855.

Table for conversion of millimètres into inches.

mm.	in.	mm.	in.	mm.	in.	mm.	in.
·001	·000039	·25	·009842	·57	·022441	·89	·035039
·002	·000079	·26	·010236	·58	·022835	·9	·035433
·003	·000118	·27	·010630	·59	·023228	·91	·035827
·004	·000157	·28	·011023	·60	·023622	·92	·036220
·005	·000197	·29	·011417	·61	·024016	·93	·036614
·006	·000236	·3	·011811	·62	·024409	·94	·037008
·007	·000275	·31	·012205	·63	·024803	·95	·037401
·008	·000315	·32	·012598	·64	·025197	·96	·037795
·009	·000354	·33	·012992	·65	·025590	·97	·038189
·01	·000394	·34	·013386	·66	·025984	·98	·038583
·02	·000787	·35	·013779	·67	·026378	·99	·038976
·03	·001181	·36	·014173	·68	·026772	1·	·039370
·04	·001575	·37	·014567	·69	·027165	1·01	·039764
·05	·001968	·38	·014961	·7	·027559	1·02	·040157
·06	·002362	·39	·015354	·71	·027953	1·03	·040551
·07	·002756	·4	·015748	·72	·028346	1·04	·040945
·08	·003150	·41	·016142	·73	·028740	1·05	·041338
·09	·003543	·42	·016535	·74	·029134	1·06	·041732
·1	·003937	·43	·016929	·75	·029527	1·07	·042126
·11	·004331	·44	·017323	·76	·029921	1·08	·042520
·12	·004724	·45	·017716	·77	·030315	1·09	·042913
·13	·005118	·46	·018110	·78	·030709	1·1	·043307
·14	·005511	·47	·018504	·79	·031102	1·11	·043701
·15	·005905	·48	·018898	·80	·031496	1·12	·044094
·16	·006299	·49	·019291	·81	·031890	1·13	·044488
·17	·006693	·5	·019685	·82	·032283	1·14	·044882
·18	·007087	·51	·020079	·83	·032677	1·15	·045275
·19	·007480	·52	·020472	·84	·033071	1·16	·045669
·2	·007874	·53	·020866	·85	·033464	1·17	·046063
·21	·008268	·54	·021260	·86	·033858	1·18	·046457
·22	·008661	·55	·021653	·87	·034252	1·19	·046850
·23	·009055	·56	·022047	·88	·034646	1·2	·047244
·24	·009449						

NOTE.—The last figure in the inches column is approximate; *i.e.* if the numeral in the seventh decimal place (not given in the above table) exceed 5, then the numeral in the sixth decimal place has been increased by unity.

ORIBATIDÆ.*

Acarina.—With the cuticle of the adult usually highly chitinised; with two pseudo-stigmata placed dorsally near the lateral margin of the cephalothorax, and furnished with pseudo-stigmatic organs. Legs of five free joints, terminated by a tridactyle or monodactyle claw without sucker or caruncle. Palpi of five free joints. Mandibles chelate, working perpendicularly, or rarely non-chelate and serrated; maxillary lip with dentate organs (maxillæ) working horizontally. Genital opening abdominal. Larvæ and nymphs with soft or leathery cuticle and monodactyle claws.

Sub-family.—PTEROGASTERINÆ.†

Oribatidæ having flexible, wing-like, chitinous expansions to the abdomen (pteromorphæ).

This sub-family consists of two genera only, *viz.* *Pelops* and *Oribata*. It is sharply distinguished from the other sub-family by the presence of flexible, wing-like, chitinous expansions attached to the lateral margin of the anterior part of the notogastral plate. The office of these organs is to be folded down over the legs, and form a protection to them. These pteromorphæ vary greatly in size; in *Oribata sphagni*, an aquatic species, they are almost obsolete; in *Oribata alata* they are very large. The larger are more flexible, and are usually carried more expanded than the smaller examples when the creature is moving. The flexibility does not consist in a power

* From *Oribata* (genus).

† Πτερὸν, a wing; γαστὴρ, the stomach.

of bending every part of the expansion, but arises from each aliform piece being attached to the notogaster by a narrow flexible band (see Chapter IX, Anatomy of the Exo-Skeleton, "Abdomen," p. 140). These pteromorphæ are folded as close to the body as possible when the legs are withdrawn beneath their shelter, but are more or less raised when the Arachnid is moving, so as to give free play to the leg. In most species the pteromorphæ do not advance anteriorly beyond the junction of cephalothorax and abdomen, or only slightly so, but in *Oribata punctata*, *O. alata*, and the foreign species *O. ovalis* and *O. languida* they are prolonged forward, sometimes as far as the point of the rostrum.

In the *Pterogasterinæ* the tectopedia are well developed, forming a further protection to the legs. The coxæ and femurs are flattened, being thin and broad, and are adapted to the shape of the sternal or ventral plate, so that they may slip easily beneath the slightly raised edge of the pteromorpha.

This sub-family is decidedly more complex and highly specialised than the *Apterogasterinæ*.

GENUS.—PELOPS,* *Koch*.

Pterogasterinæ, with the mandibles broad at the base, but suddenly becoming stiliform, and terminated by minute chelæ. Interlamellar hairs usually large and spatulate, and inserted below a square projection of the progaster.

The known species composing this genus are all rough or dull in texture, never polished; they are mostly rather large, and are all broad, indeed, usually approaching circular in form, flat on the ventral, and only slightly arched on the notogastral surface.

The **Rostrum** is very narrow and sharply pointed; it

* *Pelops*, nomen proprium (the son of Tantalus).

has a far smaller proportionate diameter than in any other genus of the *Oribatidæ*.

The **Labium** (Pl. I, figs. 3, 5; Pl. XXIV, fig. 7) is very long, almost entirely closing the opening of the camerastomum, adapting itself to the form of the rostrum; it is far longer than its width, and is prolonged anteriorly so as to form a blunt point.

The **Palpi** (Pl. I, fig. 4, *e*) are much hidden by the labium, and are not seen from the dorsal surface; they have the basal joint small and short, the second joint large, swollen, and fully as long as, or longer than, the third and fourth joints together; the latter two joints are much smaller in diameter than the second, and are almost cylindrical. The fifth or distal joint is as long, or nearly as long, as the second, it also is cylindrical, blunt-pointed, and furnished with a few fine hairs near the distal end.

The **Maxillæ** (Pl. I, figs. 4, 5, *d*) are small and short, bilobed but not deeply; like the remaining trophi, they are weak in comparison to those of other genera.

The **Mandibles** (Pl. I, fig. 6; Pl. II, fig. 9) form the most reliable distinction of the genus, being quite different from those of any other members of the family. They are very long in proportion, and often increase in width from the posterior margin until near the middle; the proximal part is subquadrangular; from their greatest width they narrow suddenly, with an almost square shoulder, and the part anterior to this shoulder is almost rod-like. They are terminated by very small chelæ, the denticulation of which is very fine, and difficult to see. There appears to be a small hollow in the substance of the mandible shown at *a*.

The **Lingua** (Pl. I, fig. 4, *g*) is well seen, it is membranous, and of the usual form.

The **Pseudo-stigmata** (Pl. I, fig. 7; Pl. II, figs. 6, 12, *s*) are inconspicuous and almost hidden by the progaster.

The **Interlamellar Hairs** (Pl. I, figs. 1 and 8) in all known British species, except *P. phæonotus*, attain a development not found in any other genus; they are

broadly spatulate, very pale yellowish in colour, and are arranged with the broad side horizontal; they point almost straight forwards, are inserted at the very base of the cephalothorax, and their insertion is hidden by a square, chitinous, lamellar projection of the progaster (Pl. C, figs. 18 and 19). This projection is often undulated, and looks as if it curved upward to give room for the insertion of the interlamellar hairs, which have a more fleshy and granular appearance than other interlamellar hairs. I believe that all writers on the *Oribatidæ* except myself have based their definitions of the genus *Pelops* upon this form of the interlamellar hairs, and the square projection beneath which they are inserted. I cannot think that this is the best definition; in the first place, *P. phæonotus* is without either, and it has always been considered a *Pelops*, and I should not imagine that anyone would doubt its belonging to this genus; secondly, the structural difference of the mandible and the state of the ventral plate appear to me to be more important distinctions.

The cephalothorax has the two **tectopodia** well developed (Plate I, fig. 3), the first being sharp-pointed.

The **Opistho-phragmatic Processes** are very long and powerful (Plate C, fig. 17, *x*, *y*); the median being developed to an extent quite unknown in other genera.

The Legs are rather slender, particularly the hind pairs.

The coxæ and femora of the second and third pairs are broad and flattened, so as to slip easily into the narrow spaces between the pteromorphæ and the ventral plate. The femurs, and sometimes the coxæ, of these legs are provided with blades (Plate I, figs. 11 and 12). The genuals are longer than in most genera. The tibiæ are often turned at an angle, or suddenly thickened shortly after their origin, becoming broad and flattened at the distal end. The tarsi, in all species known to me, are terminated by a

tridactyle claw, of which the central unguis is stronger, but not longer, than the lateral ones.

The **Pteromorphæ** are usually large and mobile; in *P. phæonotus*, however, they are rather smaller and more pointed than in other species (Plate I, figs. 1 and 3).

The **Ventral Plate** is considerably excavated in its antero-lateral parts, in order to receive the second, third, and fourth pairs of legs, the coxæ and femurs of which work in this depression. There is not any well-marked sternum, nor is there any division between cephalothorax and abdomen on the ventral surface. The apodemata scarcely show, and are very short.

The **Tracheal system** is fully developed in the adults. The *cæca* of the ventriculus are short and rounded.

The **Testes** are less embedded in the vesicula seminalis than in most other genera (Plate F, fig. 2).

In *Pelops* the adult emerges from the nymphal skin, not polished, but comparatively smooth, or only slightly granular; in most species, however, a white substance is gradually secreted which occasionally covers the whole of the notogaster and pteromorphæ; it is hardish and translucent, having the appearance of alum; it either soon shrinks and splits, or else it is secreted in ridges, I am not absolutely certain which, but whichever it be, the class of form which the substance assumes is characteristic of species; in *P. acromios* it takes the shape of long, slender ridges. In *P. lævigatus* the ridges are so broad that they rather appear to be the surface, with numerous splits and irregular pits in it (Plate I, fig. 1; Plate II, fig. 2). The substance frequently remains white; this is especially so with *P. lævigatus*, and, from Nicolet's observations, I should judge that he found *farinosus* in the same condition. I have not ever found *P. acromios* in this state; the white ridges on that species soon become the same colour as the chitin of the notogaster, and are not distinguishable from it, and this is the usual state in all species; a fact which has led Nicolet and

others to describe these ridges as being part of the exo-skeleton. It is only when a ridge is seen against the light that it is found to be translucent, whereas other markings are quite opaque; moreover, the ridges are easily washed off with a brush and water, whereas one might wash for ever without getting off any of the real chitinous projections. I have bred great numbers of *P. acromios* in confinement, but have not ever observed any emerge from the nymphal skin with these ridges already in existence.

Some species of *Pelops* are often found in great numbers on the foliage of trees, some equally numerous in the fallen needles of the fir tribe; they are also found in moss and other herbage.

The nymphs and larvæ of *Pelops* are strange and often beautiful creatures; they have the lateral margins of the notogaster strongly raised, leaving a nearly flat or slightly convex central space. The whole notogastral surface is covered with closely set, wavy, irregular folds or projecting bands of the cuticle (Plate I, fig. 2; Pl. II, figs. 3, 13). They are chiefly pink, orange, or red-brown in colour. There are only four British species known to me; the following table will be useful in identifying them.

Table for identifying British species of Pelops.

Hairs on the notogaster spatulate . . .	Stigmatic organs clavate .	*Acromios.*
	Stigmatic organs falciform .	*Farinosus.*
Hairs on the notogaster very fine (or absent)	Interlamellar hairs spatulate, proceeding from below a square projection of the progaster	*Lævigatus.*
	No square projection, interlamellar hairs not spatulate . . .	*Phæonotus.*

PELOPS ACROMIOS* (*Herm.*). Pl. I, figs. 1—12; Pl. II, fig. 13; Pl. XXIII, fig. 1.

Type Species.

Notaspis acromios,	Herm.	P. 91, pl. iv, fig. 1.
Pelops —	Nic.	P. 425, pl. iii, fig. 1.
— —	Can. e Fan.,	p. 10 (qy. var.).
— —	Haller.	P. 304.
Celæno spinosa,	Koch.	Heft 3, pl. xvii, Nymph.

Average length about ·65 mm.
Average breadth about ·55 mm.
Average projection of first pair of legs, when stretched out, beyond tips of rostrum, about ·17 mm.

Form approaching circular, very broad posteriorly.

Colour black, whole surface of abdomen rough, with irregular, vermiform ridges, leaving shallow depressions between them. These ridges, although they look black, are not part of the chitin; the creature emerges without them; they are secreted later, and are hard matter, which is translucent when seen against the light, and may be detached; this, however, would not be suspected. The actual surface is rough and unpolished.

Cephalothorax bulbous posteriorly. Rostrum very pointed. Rostral hairs fine. No true lamellæ or translamella. Pseudo-stigmata hidden by progaster. Pseudo-stigmatic organs of moderate length, *gradually clavate*, slightly recurved. Interlamellar hairs excessively large, light-coloured, spatulate, horizontal, directed forward, springing from beneath the progaster, and passing the rostrum. Tectopedia large, the first with a short free point, otherwise joined to cephalothorax anteriorly by a thin, chitinous shelf, from which springs a thick, short hair. Opistho-phragmatic processes extremely long.

* Ἄκρος, at the top; ὦμος, a shoulder.

Legs rather long; at least one spatulate hair on the outer edge of each joint except the coxa, also a whorl of fine hairs.

Abdomen large, broad, and flattish. Pteromorphæ short, their anterior edges sloping backward from their lateral angles to the progaster. They are rough, with secreted ridges, like the notogaster. The progaster has a square projection with an undulating margin of three lobes, the lateral two of these curve over the insertions of the interlamellar hairs. The notogaster has an elliptical, depressed, but slightly convex space of smooth, light-coloured chitin, which is transparent after microscopical preparation, but often looks opaque in life. Four rows of *spatulate* hairs on the notogaster, and a row of similar hairs round the hind margin. Genital plates larger than the anal, both square or slightly pentagonal.

Nymph.

This singular and handsome creature was supposed by Koch to be a separate species, and named *Celæno spinosa* by him.

The **Colour** varies a good deal in different specimens, and with age, &c.; it is usually a more or less crimson-red shaded with yellow-brown, but is sometimes almost wholly orange-brown. Cephalothorax yellower than the abdomen, legs browner, and the hairs white. When the nymph is quite mature, and also during the inert stages, it loses the crimson colour, and becomes a dirtier brown, the whole effect then is of a rather dark-coloured, opaque creature. The colour is finest when the nymph is about half-grown.

Shape pyriform, far more strongly marked in the young than in the full-grown specimens, which become rounder.

Rostrum small and narrow, with slightly concave lateral margins; it bears a pair of fine hairs near the tip.

Cephalothorax marked out into several divisions. The central part of its dorsal surface is occupied by two irregularly subelliptical depressions separated and surrounded by a raised ridge or fold, forming altogether a quadrangular figure with rounded corners and slightly constricted in the middle. The ridge dividing these two depressions is prolonged forwards so as to form a blunt point, from which two fine ridges run a short way forward with a very small joining ridge between them. On each side of these elliptical ridges is a division of the cephalothorax (the gena), which runs downward at an angle until it meets a narrow marginal platform which supports the legs. All the divisions are thickly dotted. In the anterior indentation between the elliptical ridge and the gena on each side the pseudo-stigma is placed, and is much raised. Pseudo-stigmatic organs almost globular, with short peduncles. Interlamellar hairs thick and somewhat spatulate.

Legs rather thick, third pair considerably longer than the second; the fourth reach somewhat further back, when extended, than the hind margin of the abdomen. Joints rough and nodose; anterior tarsi nearly globular at the proximal end, but produced anteriorly to a thin point. Claws very large. First tibiæ have tactile hair long. Each joint of first pair of legs has a pair of thick spatulate hairs, except the femur, which has only one. There are several short hairs, or spines, along each joint of the legs except the tarsus, which is hirsute.

Abdomen has its lateral portions sharply raised at an angle from the central area. The raised lateral parts are broadest anteriorly, gradually diminishing posteriorly until they are lost in the general surface of the notogaster. The most depressed portion of the abdomen is where the lateral raised portions join the central part; from this line the central area is slightly arched, but never attains the height of the lateral parts. The whole abdomen is a series of wavy,

more or less parallel ridges or folds, with depressed channels between. These ridges run backward and inward on the raised lateral parts, and transversely on the central part; each ridge having a curve forward in the centre, which curve is strong near the progaster, but is almost lost in the ridges lying about half way back; two or three ridges springing from the posterior margin run sharply forward like a capital letter A. There is a row of about fourteen very large and thick spatulate hairs, or spines, round the margin. These form a conspicuous feature; the two central usually cross, and, in specimens after the first nymphal ecdysis, the next pair, or even the two next pairs, also cross.

The nymphs are sluggish, and move slowly when disturbed.

The **Larva**, and the nymph before the first nymphal ecdysis, have only two pairs of hairs round the margin. These are placed posteriorly, and are very long, but not so spatulate as those of the more mature nymph.

The **Egg** is light-brown at first, but turns dark-red before hatching. It has raised, reticulated ridges upon it. There is not any deutovium stage, and the egg usually breaks at the end, not at the periphery.

Distribution.—The nymphs are chiefly found about May. Both they and the adults may be obtained in great quantities by beating oak and whitethorn trees, and amongst the fallen fir-needles in woods. It is also found in moss, &c., but not so plentifully.

The species is common, and generally distributed; it varies in size considerably. I have found a very large variety in Cornwall.

This creature has been recorded in France, Germany, Switzerland, Italy, &c.

Pelops farinosus,* *Nic.* Pl. I, fig. 13.

Pelops farinosus, Nic. P. 425, pl. iii, fig. 2.
— — Haller. P. 304.

Average length about ·55 mm.
Average breadth about ·45 mm.

This is a species founded by Nicolet. It is a somewhat difficult one to identify, and is not clearly marked. The distinctions from *P. acromios* are—the smaller size, narrower shape of the abdomen anteriorly, the pseudo-stigmatic organs being *falciform* instead of clavate, and the secreted matter often remaining whitish on the ridges instead of turning black.

Form slightly pyriform, but not departing much from the circular type; broad posteriorly.

Colour black. Whole surface of abdomen rough with irregular vermiform ridges, leaving shallow depressions between them. These ridges are secreted matter, and often preserve a white appearance as though dusted with flour. The actual surface is rough and unpolished.

Cephalothorax bulbous posteriorly. Rostrum very pointed. Rostral hairs fine. No true lamellæ or trans-lamella. Pseudo-stigmata hidden by progaster. Pseudo-stigmatic organs rather *long and falciform.* Inter-lamellar hairs excessively large, light-coloured, spatulate, horizontal, directed forward, springing from beneath the progaster and passing the rostrum. Tectopedia large, the first with a short free point, otherwise joined to cephalothorax anteriorly by a thin chitinous shelf, from which springs a thick short hair. Opisthophragmatic processes extremely long.

Legs rather long, at least one spatulate hair on the outer edge of each joint except the coxa, also a whorl of fine hairs.

Abdomen large, broad posteriorly, rather narrowed

* *Farinosus*, mealy.

anteriorly, flattish. Pteromorphæ short, their anterior edges sloping backward from their lateral angles to the progaster; they are rough like the notogaster. The progaster has a square projection with an undulating margin of three lobes, the lateral two of these curve over the insertions of the interlamellar hairs. The notogaster has an elliptical depressed space of smooth light-coloured chitin as in *Pelops acromios*. Four rows of spatulate hairs on the notogaster, and a similar row round the hind margin. Nicolet says that there are fewer of these hairs in this species than in *acromios;* I have not been able to assure myself of this in British specimens. The hairs are very caducent. The genital plates are larger than the anal, both square or slightly pentagonal.

I am not certain of the nymph of this species.

Distribution.—Found with *acromios*, and probably common, but doubtless generally taken for *Pelops acromios;* if, indeed, it be really different. It is difficult to distinguish it until after it is mounted.

Pelops lævigatus,* *Nic.* Pl. II, figs. 1—7.

Pelops lævigatus, Nicolet. P. 426, pl. iii, fig. 3.
— *acromios*, Koch. Heft 30, fig. 9.
Oribata acromios, Gervais. P. 258.
Pelops fuliginеus, Koch. Heft 30, fig. 10.
— *hirsutus*, — Heft 38, fig. 15 (?).
Celæno plicata, — Heft 3, fig. 18, Nymph.

Average length about ·55 mm.
Average breadth about ·36 mm.
First pair of legs when extended reach beyond point of rostrum about ·19 mm.

Colour dead-black, the surface *even* but not polished. After the imago has emerged some little time from the nymphal skin it usually becomes coated on the notogaster with a thick layer of a substance which looks like alum, and which I suppose to be a secretion; this,

* *Lævigo*, I smooth.

as it dries, splits irregularly all over, showing the black dorsal surface through. These splits are not straight or sharp, but are branched, twisted, and irregularly lobed; they present however, a certain general character throughout. I believe that the white matter often rubs off again, but of this I am not certain, at all events the creature is often found with its surface dark and slightly rough.

The **Rostrum** is very sharp and pointed, the posterior central part raised and rounded, with a thin, flat, peripheral border.

The **Cephalothorax** (except the rostrum) is almost entirely hidden by the progaster. The interlamellar hairs light-coloured, very large, spatulate, horizontal, directed forward, as usual in the genus. Pseudo-stigmatic organs *somewhat similar in shape to the interlamellar hairs*, but smaller and more pedunculate. Lamellæ small; translamella concave. Tectopedia large, the first with a long free point bearing a hair on its side. Opisthophragmatic processes very long.

Abdomen almost circular, but slightly narrower anteriorly. Pteromorphæ rather long, with a *straight* anterior margin extending to the median projection of the progaster; this latter is square, with an undulated anterior margin, so as to form a central elevation like half a cylinder, and two similar lateral elevations, beneath which the interlamellar hairs are inserted. *No clear depressed space on the notogaster*. Four rows of *fine hairs on the notogaster;* but one or two pairs at the hind margin are thicker (accidentally drawn less clavate in the plate than they really are).

iph.

This nymph is probably the creature which Koch describes as a separate species under the name of *Celæno plicata*.

The **Colour** varies, usually an Indian or port-wine

red, shaded with yellow and brown, sometimes the latter colours predominate. The larva and lymph are more crimson at first and more yellow-brown during the inert stages as in *P. acromios*. Legs darker; hairs whitish.

Shape pyriform. Rostrum sharper, hinder part more bulbous than in the nymph of *acromios*. Cephalothorax marked out into several divisions by raised ridges; the central posterior part of its dorsum having a median space oblong with concave sides, and an oval on each side; these spaces are depressions divided by ridges; in front of them is a smaller triangular space enclosed by a ridge; the form of these markings is not constant. The pseudo-stigmata are large, open, and upright. The pseudo-stigmatic organs are longer than in *acromios*, clavate and rough. The interlamellar hairs project over the rostrum and are filiform.

Legs thick, moderately long; joints rough and nodose. Tactile hairs long, set on projections of the tibiæ; no spatulate hairs on first pair of legs, or only very slightly spatulate ones, but the legs have numerous short hairs or spines, chiefly set in whorls.

Abdomen with lateral portions sharply raised, raised part broadest about the middle, central portion slightly arched. Whole abdomen a series of wavy ridges or folds, irregularly parallel, they mostly curve forward on the central part of the abdomen. In the posterior half of the abdomen the ridges are broken by a deep, central, longitudinal trench. The sides of the abdomen have *a row of thick, incurved, non-spatulate hairs* round the edge, and *two very long, straight ones at the posterior margin.*

The **Egg** is light-brown, reticulated with ridges; it has a deutovium stage and splits along the periphery.

Distribution.—I found the adult and nymph in great numbers in moss from the ground in fir-woods, near Swanage in Dorset. I have also found it frequently,

but not so abundantly, in moss in other localities; it is generally distributed and is not uncommon. It has been recorded in France.

The name is accidentally misspelt below the plate, the *æ* being written *e*.

Pelops phæonotus,* *Koch*. Pl. II, figs. 8—12; Pl. XXIII, fig. 2.

Pelops phæonotus, Koch. Heft 39, fig. 23.
— — Can. e Fan., p. 12.

Average length about ·45 mm.

Average breadth about ·30 mm.

Average projection of legs (first pair), when fully extended, beyond point of rostrum about ·15 mm.

Colour.—Dull red-brown or black; legs lighter; abdomen deeply marked with depressed round areolations, the whole surface looks rough, but there is not any secreted matter.

Shape.—Very pyriform, the posterior margin rounded, the anterior very narrow.

Rostrum thin, long, much curved downward, the tip not seen from the dorsal aspect in consequence of the curvature. When regarded from the sternal aspect it is seen that the rostrum is not truly pointed, but is rectangular at its distal end. The opening of the camerostomum is entirely closed by the labium, which is prolonged as a thin strip anteriorly, concealing the trophi.

Cephalothorax narrow and greatly overhung by the progaster and pteromorphæ. Dorso-vertex narrow and short; lamellæ very large, curved; cusps thereof projecting nearly as far as the rostrum; the lamellæ have rounded posterior ends, and are there almost on edge, towards the anterior ends they are almost horizontal. Each lamella has a strong, curved spine springing from the tip of its inner edge and pointing

* Φαιός, brown; νῶτος, the back.

outward. Pseudo-stigmata hidden; pseudo-stigmatic organs claviform, rather long, partly hidden, the portions which show above the progaster stand nearly perpendicularly and are short; the organs are sunk in a deep depression of the anterior margin of the abdomen formed by the pteromorphæ, the lamellæ and the progaster. *Interlamellar hairs small and fine.* The first tectopedium short, concave interiorly, and bearing a strong sharp spine pointing inward, the second similar but without the spine.

Legs.—The two anterior pairs have the femurs large and rounded, the genuals thin, long, and pointing outward and downward; tibiæ large and thickened; tarsi powerful and pyramidal. The two hind pairs of legs are thin. The claws are very heterodactyle. Each leg has a thick, spatulate hair on the outer edge of the tibia, and the two anterior pairs of legs have similar hairs on each tarsus and on each edge of each genual. There are some fine hairs on each joint of each leg; the tactile hairs proceed from slight projections of the anterior tibiæ.

The **Abdomen** is bordered by a thin projecting edge, slightly rounded on the progaster, which, however, is *entirely devoid of the square projection* usual in the genus. The pteromorphæ advance far forward, their anterior margin is very rounded, and forms a strongly sinuated line with the progaster; they do not extend quite half-way along the margin of the abdomen, *and are only attached by the anterior part of their edge*, leaving long free projections posteriorly. The notogaster has a small depressed oval of light smooth chitin in the median line near the progaster; as in *acromios*, there is a tendency to a depressed strip in the medio-dorsal line, somewhat similar to that of *P. occultus* (not known to be British). There are two pairs of short spatulate hairs, at different levels, on the hind margin. No hairs on the notogaster.

I do not know the Nymph of this species.

Distribution.—I have only found the creature at the

Land's End, Cornwall, in moss; it is rare. It has been recorded in Germany and Italy.

Genus—ORIBATA,* *Latreille*.

Equals *Oribata* and *Galumna*, Heyden.
Equals *Oribates* and *Zetes*, Koch.

Pterogasterinæ with mandibles of the form usual in the family. Interlamellar hairs setiform, filiform, serrated, or absent; never spatulate.

This is the largest genus in the family, it is also the most typical and complete. It was Latreille's original genus, which has been enlarged into a family, the name being properly preserved to the present group as being essentially the best examples. The creatures composing the genus are not only the most typical, they are also the most elaborately formed. All external parts which are to be found in any member of the family, unless the apophyses of *Nothrus* be looked upon as parts, will be found developed in this genus.

The different species exhibit considerable diversity in size. The British examples known to me vary from ·2 mm. to over 1 millimètre; many are very polished, reflecting light like a looking-glass, others are smooth but without polish; some have the whole notogaster closely punctured all over, the punctures varying in fineness in different species, but the notogaster is not really rough in any one which I am acquainted with.

The **Rostrum** is far wider and blunter than in *Pelops*, although in two or three instances, as *O. gracilis* (Plate III, fig. 9), it is tolerably sharp. In many species the genæ form distinct lobes, giving the anterior margin a trifoliate appearance.

* Ὄρος, a mountain; βαίνω, I go (or Oribasus, Actæon's dog; same derivation).

The **Labium** varies in different species, but preserves the same general character; it does not cover the whole opening of the camerostomum; it is usually somewhat longer than its width, but not greatly so, occasionally the width is the greater; it has a rounded posterior margin, and a convex or truncated anterior margin; it is not ever prolonged in the pointed form found in *Pelops* (Pl. VI, fig. 3; Pl. VIII, fig. 3, *f*; Pl. IX, fig. 3, *f*; Pl. XXIV, fig. 8, &c.).

The **Palpi** have the first joint short as usual, the second far the largest, usually nearly as long as the third, fourth, and fifth joints together; it is also generally considerably dilated (Pl. III, fig. 3; Pl. VIII, fig. 5; &c.), but not invariably so (Pl. VI, fig. 4, &c.). The third and fourth joints are short; the fifth usually slender, and provided with a few fine hairs, which are sometimes inserted in a sort of step or lobe (Pl. V, fig. 9).

The **Maxillæ** are well developed, usually bi-lobed, each lobe being dentate (Pl. IV, fig. 13, *d*).

The **Mandibles** are large and powerful, of the ordinary form, and each limb is usually quadridentate, or tridentate the two anterior denticulations coalescing.

The **Lingua** is well seen in the dissections of many species (Pl. VI, fig. 4, *g*; &c.).

The **Pseudo-stigmata** vary somewhat in different species, but are usually inconspicuous and more or less hidden by the progaster.

The **Interlamellar hairs** are usually setiform (Pl. III, fig. 9, &c.), but they may be filiform, or almost so, as in *O. piriformis* (Pl. VI, fig. 10) or they may be serrated as in *O. quadricornuta* (Pl. VIII, fig. 1), in which instance they have become spinous. They may be entirely absent, as in *O. sphagni* (Pl. III, fig. 1); but I am not aware of a single instance where they are spatulate, or clavate, or indeed of any form except those named above; they vary greatly in length in the different species.

The **Tectopedia** attain as great a development in this genus as in any; but the respective species are very differently provided in this respect, although the nature of the structure is always the same, the size only varying. In cases like *O. lapidaria* and *O. globula* (Pl. V, figs. 1, 6), where they perhaps attain their maximum, the first tectopedium is a powerful structure running parallel to the lamella, and seeming like an enlarged duplicate of that part, sharply pointed, and extending almost as far as the rostrum. The second tectopedium is always more rounded and cup-shaped, and never extends far forward.

The **Legs** are usually rather slender, the coxæ and femurs of the third and fourth pairs usually broad and flattened, so as to slip under the pteromorphæ, as in *Pelops*. The coxæ and femurs of these two pairs of legs and the femurs of the two front pairs are commonly, but not invariably, provided with blades, which attain a large size in such species as *mollicomus* (Pl. IV, fig. 1), *O. fuscipes* (Pl. VII, fig. 1), particularly on the second pair of legs. The tarsi, in most species, are terminated by a tridactyle claw, of which the central unguis is far the thickest; but in a few species, as *O. parmeliæ* (Pl. XII, fig. 1) and *O. fusigera* (Pl. XII, fig. 6), the claw is monodactyle.

The **Pteromorphæ** are not usually so flexible as in *Pelops*, although those of *O. alata* (Pl. X, fig. 1) are very mobile. In some species, as *O. alata*, *O. punctata* (Pl. IX, fig. 1), the organ is carried forward so as to form a pointed or rounded projection, extending almost as far forward as the tip of the rostrum.

The **Tracheal system** is fully developed. The **Cæca** of the ventriculus commonly of moderate length and pyriform (Pl. E. fig. 6, *cæ*).

The adults of this large genus are found in various localities, sometimes in moss, sometimes on the leaves and bark of trees, sometimes in other vegetable *débris*. They are probably, on the whole, the most widely spread, and most abundant of any genus in the family.

The larvæ and nymphs vary greatly, no general rule can be given respecting them, they are ordinarily entirely unlike the adult.

The genus is no doubt most closely allied to *Pelops*, but presents many points of analogy with *Notaspis* and *Leiosoma* (*Cepheus*). I am acquainted with nineteen British species.

In some cases the species of this genus are difficult to identify. It is almost impossible to distinguish *O. orbicularis* from *O. piriformis* by comparing the adults, because, although typical specimens differ in form, yet both species vary, and intermediate shapes occur in each; still they appear to be separate species, for the immature stages are different.

It is very difficult to give in words any plain distinction by which *O. gracilis*, *O. lapidaria*, and *O. globula* can be separated from each other, but a person accustomed to them will pick out the three species without difficulty from their general appearance and size.

I have in Plates XXIII, XXIV, given outlines of the cephalo-thoraces of all except a few species which are absolutely unmistakable, viz. *O. sphagni*, *O. alata*, *O. quadricornuta*, *O. tecta*, *O. parmeliæ*, and *O. fusigera*; the outline of *O. piriformis* will be found on Pl. A. *O. orbicularis* would be similar.

GENUS ORIBATA.

Table to assist in identification.

- Claws tridactyle
  - Having a trans-lamella
    - Trans-lamella a mere line
      - Pteromorphæ strap-like . . . . . SPHAGNI.
      - Pteromorphæ normal
        - Notogaster hairless
          - Pseudo-stigmatic organs clavate
            - Rostrum slender, cusps of lamellæ long, legs long, no light patches on notogaster GRACILIS.
            - Rostrum obtuse, cusps short, legs of usual length, light patches on notogaster . LAPIDARIA.
          - Pseudo-stigmatic organs almost rod-like, creature large and globular . . GLOBULA.
        - Notogaster with long hairs
          - Lamellæ almost as long as rostrum, first and second femurs with large blades . MOLLICOMUS.
          - Lamellæ much shorter than rostrum, first and second femurs without blades . EDWARDSII.
    - Trans-lamella a ridge standing on its edge
      - Lamellar, inter-lamellar, and rostral hairs setiform
        - Abdomen round. . . ORBICULARIS.
        - Abdomen pyriform . . PIRIFORMIS.
      - Lamellar, inter-lamellar, and rostral hairs serrated
        - Cusps of lamellæ truncated, lamellar hair set in middle of anterior truncated margin . . . . FUSCIPES.
        - Cusps long and pointed, lamellar hair springing from a shoulder near the base of each cusp . SETOSA.
  - Without any trans-lamella
    - Pteromorphæ with long processes projecting forward
      - Lamellæ large and horizontal . PUNCTATA.
      - Lamellæ entirely absent . . ALATA.
    - Pteromorphæ without such processes
      - Lamellæ very large, horizontal, and nearly touching at their inner edges
        - Anterior edges of lamellæ deeply cleft. A serrated spine inserted in the cleft . QUADRICORNUTA.
        - Anterior edge truncated, spine at the inner corner . . . . TECTA.
      - Lamellæ small, on edge, and widely separated
        - Lamellæ much shorter than the rostrum
          - Pseudo-stigmatic organs clavate, directed forward and outward CUSPIDATA.
          - Pseudo-stigmatic organs recurved, with small fusiform heads and slender peduncles . LUCASII.
        - Lamellæ nearly as long as rostrum; pseudo-stigmatic organs fusiform, horizontal, directed forward and inward . . AVENIFERA.
- Claws monodactyle
  - Pseudo-stigmatic organs short, clavate, recurved . . . . PARMELIÆ.
  - Pseudo-stigmatic organs fusiform with a terminal hair, and directed forward . . . FUSIGERA.

ORIBATA SPHAGNI,* *Michael.* III Pl. , figs. 1—8.

Oribata sphagni, Mich. Journ. R. Microsc. Soc., vol. iii, p. 179, pl. iv, fig. 6.

Average length about ·32 mm.
Average breadth about ·20 mm.

A minute aquatic species.

Colour yellow-brown.
Texture smooth and polished.
Rostrum blunt.

Cephalothorax long and conical, not depressed below the level of the abdomen. Lamellæ narrow, almost straight blades on edge; their cusps short and small, blunt-pointed, bearing a large curved lamellar hair at their points. Trans-lamella a thickened line, not a blade; pseudo-stigmata small, and hidden by the pteromorphæ; pseudo-stigmatic organs very minute, *and hidden entirely within the pseudo-stigmata.* No inter-lamellar hairs; tectopedia well-marked but rather short, the first bearing a hair. Apodemata powerful and all joined to the sternum.

Legs short, fourth pair not extending behind the abdomen. Three posterior coxæ inserted near together. Hind femurs not much flattened, no blades. One or two short thickened hairs or spines on most joints of each leg, and several long, fine ones on tarsi. Tactile hairs on all legs, largest on first pair.

Abdomen oval, progaster sinuated, the central part advancing with a large curve; it is not very clearly marked off from the cephalothorax (the drawing is too distinct). The whole notogaster polished and hairless. The *pteromorphæ are strap-like,* quite different from every other British species which I know of, *i.e.* they are so short that their length, from anterior to posterior edge, is less than their breadth from the periphery of the abdomen to their lateral bend over the legs. They

* *Sphagnum* (the bog-moss of that name).

only cover about half the femurs of the second pair. The organs are apparently becoming abortive.

The Nymph.

Colour of abdomen semitransparent, greenish-white, or yellowish-grey; cephalothòrax and legs pinkish or rather yellow. Some of the raised ridges on the abdomen brown.

Cephalothorax.—Rostrum short, bluntly-conical anteriorly, then parallel-sided, overlapped in the middle by the point of a roughly triangular marking or shield, indented on each side, which forms the dorso-vertex, and is usually divided into four parts by two longitudinal and one transverse curved ridges. The pseudo-stigmata are at the posterior angles. Behind this triangle is a smaller, usually pentagonal, space, enclosed by a ridge; these markings all vary in different specimens; a pair of strong spines (not shown in the plate) stand erect near the tip of the rostrum. The pseudo-stigmata are near together, the pseudo-stigmatic organs long and filiform. The interlamellar hairs are stout spines, and stand almost upright. The pre-ventricular glands often show through the dorsal surface near the pseudo-stigmata like two red spots.

Legs rather thick, armed with short spines on each joint.

Abdomen considerably longer than broad, attaining its full width immediately behind the progaster, which is either slightly undulated with a concave centre, or nearly straight; it is bordered by two or three ridges or folds of cuticle.

Abdomen shield-shaped, sides almost parallel; notogaster flat or with slightly raised edges, covered with numerous, irregular, shallow wrinkles or folds of the cuticle, which become more curved as they get further back. All the ridges have raised dots irregularly scattered over them. The whole periphery of the abdomen except the progaster, is *armed with long,*

straight, or slightly curved transparent spikes at some distance from each other, the anterior one being larger than that which follows, then they gradually increase in length to the hind margin.

Distribution.—The adult is usually found crawling on *Sphagnum;* the nymphs usually rolled up in a subaqueous leaf.

I have found this species only at Epping Forest, but it is doubtless to be found elsewhere; it is not uncommon, but searching for it is troublesome.

ORIBATA GRACILIS, sp. nov.,* Pl. III, figs. 9, 10; Pl. XXIII, fig. 3.

Average length about ·48 mm.
Average breadth about ·30 mm.
Average projection of first pair of legs beyond tip of rostrum about ·15 mm.

A middle-sized and rather elegantly formed species.

Colour bright brown.

Texture highly polished.

Cephalothorax *long, slender, with a very pointed rostrum.* Palpi showing from the dorsal aspect. Dorso-vertex almost triangular, very narrow anteriorly. Lamellæ nearly on edge, much broader about the middle than posteriorly. The cusps long, *blunt-pointed, standing upward and forward* and bearing a stout lamellar *hair at the point.* First tectopedium *produced to a sharp point,* and bearing a pectinated hair. Pseudo-stigmatic organs *straight, long, and moderately clavate* (they are too stout in the figure). Interlamellar hairs long and setiform.

Legs *long and slender;* two front pairs about the same length; hind femurs much flattened and with blades. Tactile hairs very long, numerous fine hairs on the other joints.

* *Gracilis*, slender.

Abdomen.—Progaster *strongly* undulated; advancing in the middle boldly over the cephalothorax. Pteromorphæ reaching far back. *No hairs on the notogaster.*

The Nymph.

The nymph is rather more complicated.

Colour of cephalothorax, legs, and a long, somewhat gourd-shaped chitinous plate on the notogaster, dull brown (not quite as red or dark as in the plate). The ortions of the notogaster which are not covered by the chitinous shield are dull ochre-yellow or greenish.

Cephalothorax broad, blunt, conical. There are two pairs of rostral hairs. Pseudo-stigmatic organs longer and less clavate than in the adult; interlamellar hairs similar to those of the adult, but smaller.

Legs shortish and stout, tibiæ of front pair considerably enlarged at the distal end where they bear the tactile hairs, which are not so long as those of the adult. Tarsi thickly clothed with fine hairs. The tibiæ bear tactile hairs on all legs. The other joints bear short, curved, rough hairs disposed in a whorl on each joint.

The **Abdomen** has the whole central and posterior parts, except a marginal line to the latter, covered by a chitinous plate, which is coarsely punctured and catches the light in numerous raised points, giving it the effect of being finely sprinkled with grey. The cuticle of the anterior portion bears three transverse rows of small chitinous sclerites of varying form, mostly smaller and rounder towards the middle, and larger and more elongated towards the lateral margin of the body; behind these is a long-shaped sclerite running backward, and a few scattered dots. There is a stout, curved hair near each antero-lateral angle. No hairs on the notogaster.

Distribution.—I have never captured the adult form

of this *Oribata*, but I found one nymph at Epping Forest and one at Lynton, Devon, and have bred the perfect creature; I found the nymph in moss on trees. The drawing of the nymph is made from an extremely perfect cast skin, and memory of what the creature was when alive. Having only two specimens, at different times, I could not spare one to draw from the life, as that frequently kills them, and I wanted to breed them and trace the species, which I did. For the same reason I could not spare one to dissect for parts.

ORIBATA MOLLICOMUS,* *Koch*. Pl. IV, figs. 1—9; Pl. XXIII, fig. 4.

Oribates mollicomus, Koch. Heft 30, pl. xx.

Average length about ·5 mm.
Average breath about ·32 mm.
Average projection of first pair of legs beyond tip of rostrum about ·05 mm.

A small and rather inconspicuous, but well-marked species.

Colour black; legs and a patch on the abdomen red-brown.

Texture dull but not areolated.

Cephalothorax.—Rostrum blunt; dorso-vertex but little narrowed anteriorly. Lamellæ narrow blades nearly on edge, almost straight, *nearly as long as the rostrum;* this brings the translamella, which is a thickened line, very far forwards, and causes *the frons to be very short.* Cusps of lamellæ pointed, and turned rather downward, carrying terminal lamellar hairs pointing in same direction. Pseudo-stigmata far apart and wide. Pseudo-stigmatic organs long, with filiform peduncles, and short rounded heads, which are flattened one way, so that when seen on edge the whole organs look nearly filiform. Interlamellar hairs very long and setiform. Tectopedia moderate

* *Mollis*, soft; *coma*, hair.

size, the first carrying a hair. Phragma broad; lateral opisthophragmatic processes short, wide, and rounded, no central processes. Apodemata short, not reaching the sternum.

Legs *short,* fourth pair hardly passing the hind margin. The two front femurs, but particularly the second, *very wide, with immense blades carried far forward.* Tarsi short.

Abdomen *a long-shaped oval.* Pteromorphæ running far back, but only slightly expanded. Progaster rounded; a large patch of light clear chitin on the notogaster near the progaster, it is not sunk nor clearly defined. Four rows of *very long flexible hairs* on the notogaster. Genital plates square, anal plates large and diamond-shaped.

Nymph.

Colour bright dark olive-brown [often rather darker than in the plate]; it looks chitinous, and might easily be mistaken for an adult. General **form** very short and wide, shield-shaped. **Texture** polished.

Cephalothorax.—Rostrum rounded, cephalothorax behind it greatly widened, bearing two small ridges like rudimentary lamellæ; dorso-vertex between them rough. Pseudo-stigmata dorsal. Pseudo-stigmatic organs long, with thin peduncles, and clavate or fusiform heads. Interlamellar hairs setiform.

Legs very short, first pair hardly passing the rostrum, third and fourth pairs *almost entirely hidden by the abdomen;* first and second femurs very wide, and *with rounded blades.*

Abdomen *very short and wide,* shield-shaped, lateral edges curved. Progaster nearly straight, hind margin bluntly pointed. Commonly a fold by the progaster. During the inert stage the cephalothorax advances much further from the progaster by the drawing out of this fold and the flexible cuticle within it, the

creature then presents the appearance shown at Pl. IV, fig. 3.

Distribution.—I have taken both nymph and adult most plentifully in spring in moss growing on dead wood. The species is generally distributed; it has been recorded in Germany.

ORIBATA EDWARDSII,* *Nic.* Pl. IV, figs. 10—17; Pl. XXIII, fig. 5.

Oribata Edwardsii, Nic. P. 438, pl. v, fig. 5.

Average length about ·75 mm.
Average breadth about ·55 mm.
Average projection of first pair of legs beyond point of rostrum about ·25 mm.

Colour dark brown. **Texture** dull and punctured all over the notogaster, so that there is not any polished effect.

Cephalothorax broad and large in proportion. Tip of rostrum very obtuse; palpi porrected. *Lamellæ very short*, not reaching half the length of the cephalothorax, rather near together; they are narrow blades, almost on edge, slightly undulated, and without cusps. Lamellar hairs long, stout, setiform. First tectopedium shows plainly from the dorsal aspect, and looks like a second lamella, parallel to the first, but it does not bear any hair. Pseudo-stigmatic organs of moderate length, clavate, and sometimes recurved. Interlamellar hairs large, setiform, and flexible. Rostral hairs large and curved. Pseudo-stigmata large and projecting. The basi-pleuron is particularly ample.

Legs long and thin. *There are not any blades to any of the joints of the front legs.* Claws large, central one very thick. Each leg of the first two pairs has a tactile hair, all other joints, except the tarsi, a whorl of curved fine hairs, and some joints have a few scattered hairs in

* Named after Milne Edwards.

addition. Tarsi well provided with fine straight hairs.

Abdomen oval. Progaster and line of pteromorphæ slightly sinuated. Notogaster not much arched, pteromorphæ *not running far back*, but often a good deal expanded. There is a row of large, flexible, setiform hairs of varying lengths, and irregularly placed round the notogaster near the edge, and two short rows of about three similar hairs nearer the centre, besides some marginal ones.

I do not know the immature stages of this species.

Distribution.—I have only found a few specimens at Loch Maree in Ross-shire, and a few at Hoddesden in Hertfordshire. Mr. Bostock sent me some from Stone in Staffordshire. Nicolet found it abundantly in France (*Bois de Satory*).

Oribata lapidaria,* *Lucas*. Pl. V, figs. 1—5; Pl. XXIII, fig. 6; Pl. D, fig. 4; Pl. F, fig. 5; Pl. G, fig. 3.

Oribata lapidaria, Lucas. Exploration scientifique de l'Algérie, Animaux articulés, p. 318, pl. xxii, fig. 11.
— — Nic. P. 437, pl. v, fig. 6.
— — Haller. P. 304.
Murcia rubra, Koch. Heft 31, pl. xxx, Nymph.

Average length about ·8 mm.
Average breadth about ·55 mm.
Average projection of first pair of legs beyond tip of rostrum about ·22 mm.

This species is Nicolet's type of his division C † † of the genus. I have doubts whether the species which we find commonly in England is really the same as Nicolet's, there are differences, but then, as before stated, in very few species do we find the English specimens identical with Nicolet's descriptions and drawings; we have to consider the extent and import-

* *Lapidarius*, pertaining to stones.

ance of the variations, and I do not think these are sufficiently substantial to found a new species on them; the more so as if our species be not *lapidaria*, then Nicolet did not find ours, which is common here, whilst I have not found his, which is in itself suspicious with such widely-distributed creatures; moreover, the English specimens are variable.

The differences from Nicolet are:—1st. That English specimens are usually much smaller, about ·8 mm. instead of 1·25 mm.; I always, however, look on size as a doubtful distinction unless accompanied by structural difference, and I have found a large variety at the Land's End. 2nd. Nicolet describes the pseudo-stigmatic organs as long, whereas in English specimens they are short; this is more important. He, on the other hand, does not figure them as long, although he makes them longer than the English.

The above measurements and the following description are from English specimens.

Colour dark, rich brown, a large elliptical patch of indistinct outline in the median line of the abdomen near the progaster, and some smaller, more clearly defined spots nearer the edge (varying in number), much lighter, and semi-transparent. **Texture** generally highly polished, especially in the Cornish specimens, but occasionally rather dull.

Cephalothorax.—Rostrum terminating in a small rounded point, ends of the genæ showing anteriorly as small cusps. *The rostrum widens rapidly* from the point. Cephalothorax rather short and wide, *dorso-vertex wide* anteriorly. Lamellæ blades not quite on edge, *cusps very short*, so that the anterior edge of the lamella looks truncated, the superior angle being very short. Lamellar hairs long and curved, reaching beyond the rostrum, inserted into the truncated edge of the lamella, not into its sharp angle. Trans-lamella a mere thickened line. First tectopedium produced anteriorly to a *very long sharp point*, which does not bear any hair, but there is a long curved hair on a

ridge near the sternal surface. Pseudo-stigmata hidden by the progaster, *pseudo-stigmatic organs short* and clavate, but varying a little in the length and in the roundness of the club. Interlamellar hairs very long and setiform. Lateral opisthophragmatic processes rather long and with a sharp inner angle, there are two small median processes. Apodemata very short, not reaching above half across the sternal plate.

Legs moderately long and delicate, a number of setiform hairs arranged on them, chiefly in whorls.

Abdomen broad, much arched. Progaster strongly sinuated, there being a sharp indentation where the pteromorphæ join the progaster. Hind margin very round. Notogaster with the light patches mentioned above; genital and anal plates far apart, former much the smaller, both subquadrate or slightly rounded. The internal parts, when dissected out, are very red, at least the adipose tissue carries much red pigment like that of the nymph.

Nymph.

This is treated by Koch as a separate species under the name of *Murcia rubra.* It is a beautiful creature.

Colour orange-red, varying to dark-pink; this is produced, not by the cuticle, which is colourless, transparent, and shiny, but by minute specks thickly scattered over the adipose tissue underlying it. **Form** diamond-shaped, the anterior half of the diamond being the longer.

Cephalothorax not above one-fifth of the entire length, and having a constriction in front of the pseudo-stigmata, narrow in front of this. Pseudo-stigmata far apart, small, and red; pseudo-stigmatic organs short, with almost globular heads on short peduncles. Rostral hairs fine, pointing forward, a similar pair a little in front of the middle of the cephalothorax. Interlamellar hairs long, curving upward and outward.

Legs thin and rather short, no enlarged joints. Tactile hairs long, other hairs fine, arranged in whorls.

Abdomen flat in young specimens, becoming more convex later. The diamond angular when young, more rounded off when the nymph is older. Two dark red spots on the progaster with a whitish space between them, spots joined by a red line, sometimes bearing two smaller red spots. A band of six black, rather clavate hairs, pointing backward, about a fifth of the distance behind the progaster. A little behind these is a transverse mark like a scratch on the skin, probably where some part of the cast skin has been attached; posterior to this is a flask-shaped patch, the larger part being anterior and the smaller extending to the anal margin, this patch is darker and thicker than the rest and strongly dotted. In the constriction answering to the commencement of the neck in the flask, are two large, crimson spots, which seem to be expulsory vesicles (see p. 179) (Claparède's renal organs) showing through the skin, in the centre of each is a small black ring which appears to surround a minute opening. A separate patch, similar to the one above described, but round, seems to cover each spot. The extreme transparency of the integument, and the colour of the internal parts, allows the latter to be plainly seen.

During the inert stage the pigment instead of underlying the cuticle seems to mix vaguely in the substance of the creature.

Distribution.—The species is generally distributed and common; the adults are not usually found abundantly, nor in numbers together; it is found in moss. Mr. Bostock, of Stone, has found the nymphs in great quantities on the bark of a dead *Cedrus deodar*. It has been recorded in Algeria, France, and Germany.

ORIBATA GLOBULA,* *Nic.* Pl. V, figs. 6—12; Pl. XXIII, fig. 7; Pl. XXIV, fig. 8; Pl. C, fig. 11; Pl. G, figs. 4, 10.

Oribata globula, Nicolet. P. 439, pl. v, fig. 1.
— — Haller. P. 304.

Average length about 1·05 mm.
Average breadth about ·77 mm.
Average projection of first pair of legs beyond point of rostrum about ·21.

A *large* species, unmistakeable when once known, *very globular*, intensely black, and *highly polished;* it has not a hair on the body.

Cephalothorax very short and broad; dorso-vertex, short, wide, with a strongly concave anterior margin. Lamellæ narrow blades almost on edge; cusps projecting some distance and having slightly *truncated ends*, from each of which springs a strong hair or spine. The cusp outside the hair has a short, sharp point. Translamella a thickened line. First tectopedia parallel to the lamellæ, and projecting forwards in a long point, but not bearing any hair. *Pseudo-stigmatic organs long and filiform* or rod-like (those at Pl. XXIII are too clavate). Interlamellar hairs near together and setiform.

Legs short and thin, well provided with fine hairs, the posterior pair pass the hind margin by about half the length of the tarsi.

Abdomen much arched on the back, very broad. Progaster strongly sinuated with its edge thickened so as to form a slight ridge. Posterior margin truncated. The pteromorphæ are usually closely pressed against the body so as hardly to show from the dorsal aspect, except just at the anterior margin. Genital and anal plates far apart, former square, latter large and pentagonal.

Nymph.

This Nymph is so similar to that of *Oribata alata*

* This should have been "*globulus,*" as that word (signifying a little globe) is a noun.

that it is excessively difficult to distinguish them. The main points of difference are that the nymph of *O. globula* is larger, more rounded in form, and shows a smaller portion of the cephalothorax than *O. alata*, and it is usually a trifle pinker in colour; the form of the apparent dark marks must not be relied on.

Colour varies a good deal; it is usually a salmon or reddish ochre shaded with pink and brown, or else olive-green, in the full-grown nymph; straw-colour to pinkish-yellow when younger. The ventriculus with its coating of cells shows as a large brown rounded mass near the anterior margin, and often the rectum shows as a smaller brown patch.

The **Texture** of the notogaster is polished and transparent.

Cephalothorax small, very little of it except the rostrum is seen; this has the sides very curved, with the rostral hairs well shown. Pseudo-stigmatic organs moderately long, strongly recurved, and with slightly lanceolate ends. Interlamellar hairs straight and very short, borne on a sort of thin, narrow shelf, which borders the progaster, and which is indented between the hairs.

Legs thin and rather short, the femurs of the first two pairs have blades. (The engraver has accidentally divided the femur of the second leg in the plate, and made an extra joint in consequence, Pl. V, fig. 7.)

Abdomen very globular, only slightly inclined to be pointed posteriorly, and very slightly truncated anteriorly. It is polished and without hairs on the notogaster.

The drawing of the nymph is taken from one shortly after the second ecdysis, and was a specimen which I found with several others as living larvæ within the dead body of the mother, and bred to the adult stage.

The **Larva** is very globular, almost transparent, with the two spots formed by the ventriculus and rectum

(or colon) very conspicuous. It is very polished and looks like a small glass bead. It is active.

Distribution.—The creature lives on lichens and minute fungi, possibly it eats mosses as well. It is common and generally distributed. It has been recorded in France and Germany.

ORIBATA ORBICULARIS,* *Koch*, type species, Pl. VI, figs. 1 and 3—9; Pl. XI, fig. 12.

Oribates orbicularis,	Koch.	Heft 3, pl. vi.
— —		Can. e Fan., p. 14.?
Oribata —	Nic.	P. 435, pl. v, fig. 2.
— —	Haller.	P. 304.

Average length about ·65 mm.

Average breadth about ·52 mm.

Average projection of first pair of legs beyond tip of rostrum about ·14 mm.

This is Nicolet's type species of his division C, and it, or the closely allied *O. piriformis* (it does not matter which), may well serve for a type of the whole genus. It is a medium species without extreme developments, contains almost all the parts found in any, and is probably the commonest British species, although not quite so universally distributed as *O. punctata*.

Colour dark red-brown; a vague lighter patch on the notogaster near the progaster.

Texture finely punctured, not very polished; this is a point which appears to be peculiar to the British specimens, the Continental are described as polished. I do not think this a sufficient difference on which to found a new species, particularly as other species vary in this respect; and moreover I have not much confidence in its having been correctly distinguished from *O. piriformis*.

Cephalothorax.—Rostrum blunt, the genæ showing as distinct projections rather longer than the frons. Two pairs of rostral hairs (only one shows in the plate). Cephalothorax long; dorso-vertex short,

* *Orbiculus*, a little globe.

rather narrow. Lamellæ large blades nearly on edge, somewhat sinuated, and considerably wider anteriorly than posteriorly; cusps broad, not long, truncated; lamellar hair inserted in a notch in the middle of the truncated edge; hair itself long, straight, setiform; *corner of the cusp outside the hair rounded. Trans-lamella a narrow blade on edge*, of even width almost throughout. Pseudo-stigmata large, open, projecting. Pseudo-stigmatic organs short, spatulate, slightly re-curved. Interlamellar hairs long, setiform, flexible. Tectopedia large, first projecting in a long point, second wide and rounded. Opisthophragmatic processes long, lateral ones large and square, two smaller central ones very near together. First and second apodemata joined to the sternum. The inter-stigmatic hairs, and some of those on the legs, may be very finely imbricated.

Abdomen *nearly round*, arched, slightly truncated anteriorly. Progaster strongly sinuated. Notogaster hairless, and with the above-named light patch. Anal plates large, at some distance from the hind margin. The form of the abdomen, although typically round, varies a good deal.

Nymph.

This nymph has a strong resemblance to that of *O. lapidaria*, except in colour; there are, however, points which render it easy to distinguish the two.

Colour bright pinkish-brown, varying to dirty yellow-brown; legs pinkish.

Texture much dotted and slightly rough, and wrinkled with very small markings.

Form pyriform, approaching diamond-shaped, the anterior part of the diamond being the longer, and the angles rounded.

Cephalothorax short, constricted about the middle. Rostrum blunt. Pseudo-stigmata rather dorsal. Pseudo-stigmatic organs short, with clavate heads, approaching globular. Interlamellar and rostral hairs large, curved, *serrated.*

Legs of moderate length, about even thickness

except tarsi. Each of the three central joints bears a whorl of short, curved, *serrated* hairs at its distal end. Tactile hairs on all legs.

Abdomen.—Progaster concave, usually two small brown spots near it. A large, flask-shaped, thickened patch on the notogaster, strongly dotted, the larger part being anterior, and the smaller extending to the posterior margin of the abdomen. In the constriction answering to the commencement of the neck in the flask (which, however, is wide) are two large subglobular brown spots on the edge of the body, which are Claparède's renal organs, showing through the cuticle. On the antero-lateral angle of the abdomen is a large curved serrated hair; and there are two rows of short, curved, fine hairs on the notogaster, and two pairs of short ones on the hind margin.

Distribution.—The perfect creature may be obtained in great quantities by beating oak trees in spring. The nymphs and larvæ in the same way in summer. Both are also found on other trees and in other places, but not so abundantly; the nymph appears to frequent the bracts. The species is common and generally distributed. It has been recorded in France, Germany, and also in Italy; in the last case the size given is greatly in excess of the specimens found by Nicolet and myself, this may be local difference.

ORIBATA PIRIFORMIS,* *Nic.* Pl. VI, figs. 2 and 10; Pl. A, figs. 1—9, and 11, 12; Pl. B, figs. 1, 2, 6, 9, 11, 13, 15, 18, 19, 21, 23, 25, 27, 28; Pl. C, figs. 1, 3—7, 15.

Type species.

Oribata piriformis, Nic. P. 436, pl. v, fig. 3.

Average length about ·65 mm.
Average breadth about ·40 mm.

* *Pyrum vel Pirum*, a pear; *forma*, shape.

Average projection of first pair of legs beyond tip of rostrum about ·14 mm.

It is almost impossible to distinguish the adult of this species from that of *O. orbicularis*, but the nymphs and larvæ are different.

The drawings are made from extreme forms of each species, but many intermediate forms occur in each, so that breeding is the only reliable test; both are easily bred.

The differences between the adults are that this species, although of the same length, is narrower and more pyriform, thus the bulk is less. The outer corner of the cusp is pointed or angular instead of rounded, and the notogaster is more highly polished, and has not usually the slightly lighter patch found in *O. orbicularis;* still I do not profess to be able to distinguish captured specimens; and I should not have considered it a separate species were it not for the immature stages, which seem decisive, and the habitat.

Colour red-brown. **Texture** *highly polished.*

Cephalothorax.—Rostrum blunt, the genæ showing as distinct projections rather longer than the frons. Cephalothorax long. Dorso-vertex short, rather narrow. Lamellæ large blades nearly on edge, somewhat sinuated, and wider anteriorly than posteriorly; cusps broad, not long, truncated. Lamellar hair inserted in a notch in the middle of the truncated edge; hair long, straight, and setiform: *Corner of the cusp outside the hair sharp-angled or pointed. Translamella a narrow blade on edge of even width almost throughout.* Pseudo-stigmata large, open, projecting. Pseudo-stigmatic organs short, spatulate, slightly recurved. Interlamellar hairs long, flexible, setiform. Tectopedia large; first projecting in a long point, somewhat recurved; second wide and rounded. Opisthophragmatic processes long; lateral ones large and square. Two smaller central ones very near together. First and second apodemata joined to the sternum.

Abdomen *pyriform*, arched. Progaster strongly sinuated. Notogaster hairless. The form, although typically pyriform, varies a good deal.

Nymph.

Colour and **texture** vary in different parts of the body. Rostrum and legs dark brown, rather rough. Provertex light yellow or ochre-colour, and polished; posterior to this are two rolls of skin, light greenish-brown, and leathery. The cuticle of the abdomen is whitish, but the notogaster is almost entirely covered by a chitinous plate, which is darkish olive-green in a fully-grown nymph.

The shape of the whole animal is pyriform, but not regularly so; the increase in width being usually in steps, not sloping.

Rostrum pointed, its lateral edges much curved, and its posterior somewhat overhung by the next division of the cephalothorax. Rostral hairs fine.

Cephalothorax posterior to rostrum, divided into three steps or divisions, giving it a telescopic effect, of these divisions the foremost is the longest, and is almost cylindrical. The rostrum and first pair of legs seem to be inserted within it. The two hinder steps are rounded rolls of cuticle, the posterior the narrower and more sharply cut; during the inert stage these two rolls become straightened, and the creature then looks longer in proportion. Pseudo-stigmatic organs globular, on very short peduncles. Interlamellar hairs long, setiform, and with a double curve.

Legs thick, about equal width throughout. The fourth pair do not pass the hind margin. Tarsi clothed with hairs; a few fine hairs on most joints.

Abdomen very square, with rounded corners and posterior margin; its anterior part is the highest, but it is not much arched. Notogaster almost entirely covered by a chitinous shield, which is finely punctured all over, and hairless.

Distribution.—Both nymph and adult live in moss. It is common and generally distributed; it has been recorded in France.

ORIBATA FUSCIPES,* *Koch.* Pl. VII, figs. 1—2; Pl. XXIII, fig. 8.

Oribates fuscipes, Koch. Heft 6, pl. viii.
Zetes ephippiatus, — Heft 3, pl. vii, Nymph (?).

Average length about ·63 mm.
Average breadth about ·40 mm.
Average projection of first pair of legs beyond tip of rostrum about ·15 mm.

Colour usually dark rich red-brown.

Texture *extremely polished.* Reflecting objects with great distinctness. Creature much arched on the back, shape of abdomen a very long ellipse. Cephalothorax much narrower than the abdomen.

Cephalothorax small, rostrum very pointed. Lamellæ large, the anterior portions *almost horizontal, not on edge.* Cusps *long and truncated*, not ending in a point; lamellar hair strong, curved, serrated, springing from an indentation *in the centre* of the anterior truncated edge of each lamella; lamellæ near together toward their tips. Translamella a *short, wide blade, nearly horizontal.* The tectopedia small and not conspicuous, but the first one very pointed. A strong, pectinated, curved hair from each gena, the two nearly meeting in front, as in *quadricornuta. Pseudo-stigmatic organs long and standing almost upright*; they are thin, rough, and slightly thickened towards the ends in a lanceolate manner. Interlamellar hairs long, upright, serrated.

Legs.—First and second pairs rather long. Fourth pair do not quite reach the hind margin. Femurs of first two pairs of legs broad and flattened, with broad, thin blades, which are rounded anteriorly in the first

* *Fuscus*, brown; *pes*, a foot.

pair, but in the second pair are prolonged forward and form *a large, rather obtuse point*, which is a special character of the species.

Abdomen.—Progaster rounded, notogaster extremely polished; a row of long, fine, widely-set hairs near the margin, and a pair of similar hairs on the posterior part of the notogaster, but within the marginal row, and occasionally a few nearer the centre. Anterior edge of the pteromorphæ very straight. These organs are small, and fade into the general margin of the abdomen without the point of termination being visible except on very close observation. Hind margin rounded.

Nymph.

This is probably the creature described by Koch as a separate species under the name of *Zetes ephippiatus* (Heft 3, pl. vii).

Colour of tawny port-wine, taking a yellow shade in the lights. The alimentary canal shows through the dorsal surface, forming a large, dark red-brown patch. There is often a smaller round patch of the same colour in the median line, arising from a ball of fæcal matter in the hind gut, showing through the dorsal surface. Legs and cephalothorax of much the same colour as the abdomen. The notogaster is closely covered with raised granulations which catch the light.

Cephalothorax broad and short, much narrower than the abdomen, considerably raised in the middle. Rostrum short, the palpi not visible. Pseudo-stigmatic organs long, almost filiform, but slightly diminished towards the distal end and doubly curved. Interlamellar hairs setiform. Rostral hairs fine and curved.

Legs stout, rather short, and wide apart, especially the two last pairs, the femurs of which are unusually thick and widened distally. Tibiæ and genuals of the two front pairs, and tibiæ of the hind pairs of legs, bear long tactile hairs; tarsi all clothed

with longish hairs, and there is a whorl of fine, curved hairs on each other joint, except the coxa, of each leg.

Abdomen broad and shield-shaped, its proportion of length to greatest breadth being about nine to seven. Progaster much wider than cephalothorax, very distinct. Notogaster, considerably arched, and without hairs, but there are a few, very fine and short, round the posterior margin, and there is a larger one at the antero-lateral angle, which is not shown in the plate. The nymph when inert resembles that of *O. gracilis* in the same condition, but has fewer pieces of detached chitin.

Distribution.—The nymph and perfect creature live at the roots of mosses. I have found the species only at Epping Forest: it appears to be rare.

The species has been recorded in Germany (near Regensberg); it is stated to be scarce there.

ORIBATA SETOSA,* *Koch.* Pl. VII, figs. 3—12; Pl. XXIII, fig. 9.

Oribates setosus, Koch. Heft 30, pl. xix.
— — Can. e Fan., p. 15.
Oribata setosa, Nic. P. 436, pl. v, fig. 4.
— — Haller. P. 304.
— *notata*, Thörell. Ofversigt K. Vet. Akad. Stockholm, 1871, p. 683.
Murcia trimaculata, Koch. Heft 3, pl. xxi, Nymph.

Average length about ·54 mm.

Average breadth about ·38 mm.

Average projection of first pair of legs beyond tip of rostrum about ·1 mm.

Colour very dark chitinous-brown, with a vague lighter patch at the anterior margin of the notogaster; pteromorphæ and legs somewhat lighter.

Shape broadly pyriform with very round posterior margin.

Cephalothorax considerably narrower than the abdo-

* *Setosus*, bristly.

men and small in proportion. Tip of the rostrum small; the cephalothorax behind it has a somewhat convex lateral margin. Lamellæ large, set nearly on edge; cusps almost horizontal, *terminating in a very long, sharp point, which almost reaches the point of the rostrum.* The translamella is a blade, and starts just behind the cusps, *forming a sharp angle which bears a strong serrated spine* (the lamellar hair); between *the two spines the translamella has a deep indentation of a vandyke shape.* The lower edge of the translamella has a blunt central point directed backward. The first tectopedium on each side projects as a long free point, almost as far as the rostrum, and bears a long, curved, serrated spine. Pseudo-stigmata hidden below the progaster. Pseudo-stigmatic organs moderately long, rough, gradually thickened toward the distal end, and somewhat recurved. *The interlamellar hairs long, rigid, serrated, and near together.* Lateral opisthophragmatic processes large and square; no central processes.

Legs of medium length, the genuals and tibiæ of the two front pairs and the tibiæ of the third pair each bear *one* curved, serrated spine on the outer side, paired by a fine hair on the inner side; the tactile hairs are small, the tarsi thickly clothed with fine hairs.

Abdomen slightly longer than broad. Progaster divided into three lobes by narrow and shallow indentations at the commencement of the pteromorphæ. Posterior margin much rounded. The line of the pteromorphæ fades into that of the lateral margin of the abdomen without any marked point of division. The texture is smooth but dull; there are one or two rows of rod-like, rough hairs round the margin (they are too pointed in the figure).

This is a very varying species, in some specimens the cusps of the lamellæ are short and rounded, and look as though they were worn down; and in some specimens the pseudo-stigmatic organs are more clavate than in others. Nicolet describes them as almost

cylindrical, but he draws them gradually thickened towards the end, which I consider to be the true type-form. Nicolet draws two rows of closely set hairs all round the lateral and posterior edges of the notogaster, but he refers the species to Koch, who only draws one; I usually find one complete row and a part of a row outside it towards the posterior margin (not shown in the figure). Nicolet draws the hairs as fine and pointed, whereas they are more rod-like; this is probably the fault of the engraver (mine has to some extent done the same). Koch's drawing has the abdomen much narrower. I have one extremely small specimen with the abdomen as in Koch's figure, but it has the two rows of hairs very plainly. Thörell's specimen (from Spitzbergen) had only one row of hairs, he gives the above differences as reasons for considering his a new species. I incline to the opinion that they are all one, particularly as I have had an immature specimen from still further north. It is possible that the small specimen may be a different species, but I do not at present see sufficient proof of it.

Nymph.

This nymph is probably the creature described by Koch under the name of *Murcia trimaculata*.

Colour of rostrum and legs light pinkish-brown. Texture of same parts more or less chitinous. Abdomen at the periphery semitransparent, bluish-white; a saddle-shaped patch, formed by the alimentary canal, &c., frequently occupies part of the notogaster, and is often inclined to yellow-green. The expulsory vesicles form an almost black patch on each side, which from its situation at the edge of the body, appears half elliptical (by longitudinal bisection) from the dorsal aspect.

Cephalothorax obtusely conical. Rostrum plainly divided from the remainder of the cephalothorax, and

different in colour; it bears two pairs of stout, rough hairs, one in front of the other. The remainder of the cephalothorax is much lighter in colour. Pseudo-stigmatic organs clavate and rather short; the inter-lamellar hairs and a pair of hairs near the rostrum are strong, rough spines.

Legs of moderate length, hind pair not reaching the posterior margin of the notogaster, they are rather profusely haired; tactile hairs on first pair of legs very long. Hairs of the tarsi long and numerous; there is a long hair on the genual of the first leg, and a number of rough and smooth hairs on the various joints of the respective legs.

Abdomen.—Progaster slightly concave, as wide as the base of the cephalothorax but not wider. The abdomen widens gradually until a little beyond the middle, then contracts more suddenly and forms a slight posterior point. The dorsal surface is transparent, allowing the internal organs to be plainly seen; the pre-ventricular glands are conspicuous and appear to lie under the anterior margin of the abdomen; the ventriculus is also very plainly seen, behind it an oval semitransparent space is equivalent to the hind gut. The notogaster has a few distant and irregular folds in the cuticle, sometimes going right across the creature.

There is a pair of rough spines on the notogaster near the posterior margin, two pairs of similar spines on the hind margin itself, or slightly underneath, a row of about four similar spines on each lateral margin of the abdomen, and three pairs on the anterior and central parts of the notogaster; there is also a very strong spine standing almost at right angles to the margin a trifle behind the antero-lateral corner, and a rather smaller spine crossing it at an angle.

Distribution.—The nymph may be found in considerable numbers in meadows in June by sweeping the long grass. The perfect creature may be taken in the

same manner. The species is rather common; it has been recorded in Germany, Italy, and France, and at Bell's Sound, Spitzbergen. I am also indebted to the kindness of Captain Feilden, of Norwich, for the opportunity of examining an *Oribata* which his sharp eyes had discovered in a crevice of a piece of rock at the remote polar region of Franz-Joseph Land. It proved to be the cast skin of a nymph of this species.

ORIBATA QUADRICORNUTA,* *Michael.* Pl. VIII, figs. 1—10.

Oribata quadricornuta, Michael. Journ. R. Microsc. Soc., vol. iii, p. 181, pl. iv (1880).

♀. Average length about ·58 mm.
Average breadth about ·37 mm.
Average length of legs of all pairs about ·30 mm.
The ♂ is usually about a quarter smaller.

A medium-sized, very complex species, forming a step between *O. setosa* and *O. punctata*.

Colour chestnut-brown, a vague lighter patch on the notogaster, near the progaster; legs also lighter.

Texture smooth, but not very polished.

Shape pyriform, rather broad.

Cephalothorax.—Rostrum rounded, rather narrow, with a flattened, depressed, anterior margin (fig. 6, *a*), which has two points (or one cleft in the middle). The rostral hairs are great curved spines *strongly pectinated on their outer edges*, almost smooth on the inner ones (fig. 6, *b*). Hinder part of the cephalothorax broadly conical, but almost concealed by the lamellæ, pteromorphæ, &c. Lamellæ *extremely* large and very peculiar, they are *very broad*, so that the hind margins extend almost across the whole cephalothorax. This arrangement obtains also in *O. tecta* and *O. punctata*. The lamellæ are *horizontal* in general position, but each lamella is arched, the inner edge being the lowest part. The internal corners of the

* *Quadrus*, four-square; *cornutus*, horned.

hind margins are produced, and form short, blunt points, which run inward and backward, and almost touch, assuming the appearance of a translamella, but I do not think they are the true homologues of that organ. The lamellæ again almost touch before the commencement of the cusps; every line of the lamellæ is curved and sweeping. The result of all this is that the visible dorso-vertex enclosed between the lamellæ and the progaster resembles one of the trefoils found in Gothic ecclesiastical windows. *There are two cusps* to each lamella, or rather the anterior part of each lamella has a great *vandyke-shaped indentation* lying between *two long blade-like horns*, which reach as far the point of the rostrum, so that the whole lamella looks like an old-fashioned boot-jack. The lamellar hair proceeds from the *centre of the indentation*, and is a great serrated spine, reaching considerably beyond the tip of the rostrum (fig. 3, *m*). There is not any true translamella. Pseudo-stigmata hidden by the progaster. Pseudo-stigmatic organs long, rough, and falciform, curving inward. (They are hardly pointed enough in fig. 1.) Interlamellar hairs very long, serrated spines; tectopedia very large, the first are exceptional; they are broad blades, the greater part of which stand free, *the anterior edges strongly serrated* (figs. 7 and 8); there is a curious horseshoe-shaped mark on the under side. The second are rounded and very wide, enclosing a space apparently unnecessarily large for the first leg. There is a small third tectopedium behind the second leg. Lateral opisthophragmatic processes large, projecting inward; central ones very small and weak. Apodemata not reaching the sternum.

Legs thin, front pair with coxæ turned almost at right angles. Coxæ and femurs of two hind pairs broad and flattened, no blades. Genuals and tibiæ of two front pairs, and tibiæ of fourth pair, each bear a short, stout, rough spine on their outer edge. A few fine hairs on each joint, tarsi well furnished with them.

Abdomen (without pteromorphæ) broadest where the pteromorphæ cease posteriorly; abdomen with pteromorphæ widest about, or a little behind, the middle. Progaster much sinuated, particularly the edges of the pteromorphæ, which are marked with several fine parallel striæ. Pteromorphæ large and extending far back. A row of long flexible hairs round the notogaster, and about three pairs on the posterior margin at different levels.

Berlese, in his 'Acari, Miriapodi e Scorpioni Italiani,' fasc. ix, December, 1883, pl. ii, figures and describes an *Oribata* which he identifies (I cannot see why) with *O. calcaratus*, Koch (Heft 2, pl. 13). It is very like the present species, but does not appear to be identical; it has setiform pseudo-stigmatic organs instead of clavate; the pectinated rostral hair of *O. quadricornuta* seems to be absent, and the posterior form of the lamellæ different; besides other variations.

Nymph.

The most striking features are the quantity and size of the spines.

Colour pale red-brown or flesh-colour. Apex of rostrum and legs a darker shade of same colour.

Texture shiny and transparent.

Cephalothorax conical, slightly longer than broad; anterior half with a somewhat convex, posterior half with a decidedly concave, lateral margin. Rostrum pointed. Pseudo-stigmata slightly projecting tubes looking straight upward. Pseudo-stigmatic organs very long, rough, gradually but slightly thickened toward the distal end, somewhat curved, and pointing upward and outward. Interlamellar hairs extremely long, serrated, curved spines; much longer than the cephalothorax. In front of these is a second pair of similar, shorter, but still long spines on the dorso-vertex,

and in front of these again are the rostral hairs, which are similar spines still shorter, although even they are long; their position is remarkably dorsal, they are nearer together than the pair of spines behind them, and these are nearer together than the inter-lamellar.

Legs.—First and second pairs nearly equal thickness throughout, third and fourth pairs have coxæ and femurs enlarged. The tarsi are the longest joints, except in the fourth pair, where the tibiæ equal them. There are the following curved, serrated spines, on the legs, similar to those above described but shorter: viz. two on each femur of the first and third, and three on each of those of the second pair of legs; two on each genual and tibia of first and second pairs and one on each tibia of the third and fourth pairs; two, much smaller, on each tarsus of second and third pairs. Tactile hairs borne on conical projections. Tarsi with numerous fine hairs, and a few on the other joints.

Abdomen.—Shield-shaped, arched, with a great fold near the progaster, a short, truncated, conical projection in centre of hind margin; on each side of this is a serrated, curved spine, directed backward and inward. There are about seven similar spines, almost equidistant, along each side of the abdomen; a very large one near each antero-lateral angle, another a little further in, also very large; and a pair shorter near the middle of the progaster. Two pairs behind these, on the notogaster, and another pair on the same further back and wider apart. Ventral surface bowed. Legs set far in. Anal plates large and set far forward.

The nymph appears to be social and to form a kind of web in the wood.

Distribution.—I once found a number of this species in the decayed wood of an old tub which had been lying a long time in a garden in Warwickshire.

The adults were chiefly on the surface, and the immature stages in the substance of the wood. I have not ever again found it in any quantity, but Mr. C. F. George has found the species at Kirton-Lindsey, Lincolnshire; and I have found it at Epping Forest and at the Land's End, Cornwall.

ORIBATA TECTA,* sp. nov., Pl. VIII, fig. 11.

Average length about ·21 mm.

Average breadth about ·11 mm., measured below pteromorphæ.

Average projection of first pair of legs beyond tip of rostrum about ·037 mm.

This will be seen by the measurements to be about the smallest of the British *Oribatidæ* which I am acquainted with, yet it is an elaborately formed species.

Colour dark-brown. **Texture** polished, without any markings or hairs on the dorsal surface. It is rather long-shaped.

Cephalothorax slightly more than a third of the entire length. Rostrum ending in a strong blunt point or knob, thence the cephalothorax is conical with rather convex lateral margins. The lamellæ *horizontal*, very large and broad, *standing quite free*, except at the hind margin; it is one of the species where the *inner edges of the lamellæ almost touch*, sometimes they touch and join for a short distance. Dorso-vertex small and almost triangular. Each lamella is *truncated anteriorly* and the truncated edge is indented by a shallow notch, which leaves a point at the inner angle, which point, when examined with a power of about 200 linear, is seen to be bifid; *it bears the lamellar hair* which is a rough spine; the notch also leaves a very sharp, and slightly longer, point

* *Tectus*, covered (as with a roof).

at the exterior angle. The inner sides of the free portions of the lamellæ are almost straight, the outer edges sinuous, curving strongly inwards to join the inner anterior angles of the pseudo-stigmata. Each lamella is narrowest anteriorly and increases in width until it reaches the inward curve towards the pseudo-stigma; the lamellæ almost reach the tip of the rostrum, and much resemble those of *O. punctata.* The pseudo-stigmata scarcely project beyond the anterior edge of the pteromorphæ. Pseudo-stigmatic organs very long and filiform or slightly clavate (they are too much so in the Plate). Inter-lamellar hairs long, rough, and rod-like, but pointed at the ends; they usually lie just under the edges of the lamellæ, and seem as though attached thereto. The palpi project. The first tectopedia are strongly developed, and are sinuated, so that the insertions of the first pair of legs are sunk in deep, close cavities.

Legs rather short and stout. The tibiæ and tarsi of the first two pairs thick in proportion to the other joints. The fourth pair do not reach very much behind the abdomen.

Abdomen rather long and narow, pteromorphæ large, usually a good deal expanded, they run far back, and are joined to the abdomen by a sinuated line, they also have a sinuous anterior margin.

I am not acquainted with the immature stages of this species.

Distribution.—It lives in moss. I have found it at Epping Forest, Dorking, and other places; probably it is common, but from its minuteness may escape detection.

Oribata punctata,* *Nic.* Pl. IX, figs. 1—14; and Pl. XXIII, fig. 10.

Oribata punctata, Nic. P. 434, pl. iv, fig. 7; pl. ii, fig. 3.
— *nitens*, — P. 433, pl. iv, fig. 8.?
Oribates ovalis, Koch. Heft 3, pl. v.
— — Can. e Fan., p. 14 ?

Average length about ·65 mm.
Average breadth about ·45 mm.
Average projection of first pair of legs beyond tip of rostrum about ·20 mm.

This species has an extreme resemblance to Nicolet's *O. nitens;* indeed, I have grave doubts whether they are distinct. The main differences are: that *punctata* is finely punctured all over, whereas *nitens* is smooth and polished; and that *punctata* is considerably smaller than *nitens*. Nicolet adds that the abdomen of *punctata* is without hairs, and that the points of the pteromorphæ are more prolonged anteriorly in *punctata*. I am not able to confirm his view in these respects, at least as to English specimens; the hairs on the abdomen are thinner in *punctata* than in Nicolet's drawing of *nitens*, but there certainly is a well-marked row of hairs down each side of the abdomen, as strong as in the English polished specimens; these hairs, however, like those of many of the *Oribatidæ*, are very caducous. I cannot observe that the points of the pteromorphæ project further forward in the dotted than in the polished English specimens. The mere fact of difference of size I do not usually consider to be sufficient to constitute a good species unless it be very marked and very constant in both sexes, and even then I regard it as a doubtful character; the decidedly punctured cuticle, however, all over the dorsal surface does appear a distinction; very little assistance can be got from the immature stages. I have bred both *nitens* and *punctata* and I am not able to see any

* *Punctatus*, dotted.

difference between the larvæ or nymphs of the two species: for this reason I have only figured the nymph of one, as it would be simply repetition to draw both; but on the other hand, Nicolet figures the eggs of the two species which appear somewhat different. Nicolet has called them distinct species, and I am not prepared to say that they are identical, but I prefer treating them as varieties. The two forms are frequently found together.

I have used Nicolet's name of *punctata* instead of Koch's earlier name of *ovalis*, because Koch has also an *Oribates ovatus* which would be liable to cause confusion, and one is glad to have an opportunity of using Nicolet's name, which really marks the species. Nicolet having unfortunately given the name of *ovalis* to another species, I think it is best to drop it altogether.

It may be said that I ought not to call this species as found in England *punctata* at all when it has hairs on the abdomen, but Nicolet says that his species is very common in France. The present species is perhaps the commonest of the British *Oribatidæ;* but I have not found any like it entirely without hairs on the abdomen. It is scarcely likely that the very common French species should be entirely absent here, and the abundant British species equally absent in France.

Colour varies from chestnut-brown to black. Nicolet says that the dull specimens (*punctata*) are dark-brown and the polished ones (*nitens*) black. Koch and Canestrini describe their *ovalis* as black. I have rather found in England that the polished examples are apt to be brown and the dull ones black. In either case the legs, pteromorphæ, and lamellæ are lighter.

Texture varies as explained above.

General **Form** elliptical, slightly truncated posteriorly.

Cephalothorax almost hidden by the lamellæ, which are very large, undulated, broad blades, almost *horizontal, reaching as far as, or beyond, the point of the*

rostrum, their inner edges almost or quite *touching about the centre*, truncated anteriorly. Truncated edges with very shallow indentations. Lamellar hairs from the *inner angles*, short and hooked downward, but seeming to run backward under the inner edges of the lamellæ. No translamella. First tectopedia small and hidden by the pteromorphæ, second, larger and broad. Pseudo-stigmata far apart, pointing forward. Pseudo-stigmatic organs medium length, gradually but slightly thickened toward the distal end, which appears truncated when seen from above using a considerable amplification. Interlamellar hairs long, thick, setiform. Lateral opisthophragmatic processes rather long and roughly triangular. Apodemata short.

Legs long and thin, no blades; hairs on them fine and scattered.

Abdomen arched, hind margin slightly truncated; sometimes rather concave. Progaster rounded, narrow. Pteromorphæ large, running far back, clearly marked posteriorly, *prolonged very far forward, and ending anteriorly with long, pointed blades, which almost reach the tip of the rostrum*, leaving long, narrow spaces between them and the lamellæ, in which the first pair of legs work, and at the posterior end of which the pseudo-stigmata are placed. There is a row of fine hairs, very varying in size, round the notogaster some distance within the edge; also about three pairs forming a double median line, and one or two pairs on the hind margin hooked downward. Genital plates square and placed far forward. The cephalothorax being very short on the sternal side.

A very varying species. Extreme forms are so different that it is difficult to believe them the same, but every intermediate stage may be found. The shape of the lamellæ is not constant, although its general character is.

Nymph.

Colour brown, varying in tint. **Texture** leathery, *deeply wrinkled all over*. General **form** a long hexagon, the sides being much the longest.

Cephalothorax.—Rostrum almost pointed. Rostral hairs small, curved, near together. Cephalothorax usually having an anterior sub-triangular, and three posterior, irregularly oblong spaces, enclosed by ridges or folds of the cuticle; these markings vary. Pseudo-stigmatic organs long, rough, almost rod-like. No interlamellar hairs.

Legs short, hardly reaching the hind margin, rough, almost equal thickness throughout in general line, but joints shaped; beset with short spines on the outer edges.

Abdomen flat. Progaster slightly concave. Notogaster deeply wrinkled. Wrinkles tend to run in undulating lines along the lateral margin, and turn at an angle outward to the cephalothorax. Other wrinkles enclose a small triangle near the progaster, with several transverse folds behind it and enclose another triangle behind the middle of the abdomen, with more transverse folds behind it. All these markings, however, are very irregular, undulating, and varying. [The engraver has made them too straight]. There are a few inconspicuous rough hairs on the notogaster.

Distribution.—This species is extremely common in moss, on trees, and about vegetation, in all parts of Britain which I have searched; it is very hardy, and will endure very unfavorable conditions of temperature and hygrometric state of the air; it also seems to be pretty well proof against the attacks of predatory *Acarina*. I have had *Gamasids* and other predatory creatures in the cell with *punctata* for some days without the *Oribata* appearing to be injured. It has been recorded in France, Germany, and Italy.

ORIBATA ALATA* (*Herm.*). Pl. X, figs. 1—5, 12.

Acarus coleoptratus, Linnæus. "Fauna suecica," 2nd edit. (Latreille's), No. 1973.
Notaspis alatus, Herm. P. 92, pl. iv, fig. 6.
Zetes — Koch. Heft 31, pl. vi.
— *dorsalis*, — Heft 2, pl. xiv.
Oribates climatus, — Heft 31, pl. v ?
Zetes climatus, — Uebersicht, Heft 3, p. 100 ?
Oribata alata, Gervais. In Walckenaer, t. 3, p. 258.
Galumna — Heyden. Isis, 1828.
Oribata — Nic. P. 431, pl. iv, fig. 1.
Oribates alatus, Can. e Fan., p. 13.
— *climatus*, — p. 13. ?
Zetes satellitius, Koch. Heft 31, pl. xiii, Nymph.

Average length, ♀ about ·73 mm.
Average breadth, ♀ about ·55 mm.
Average projection of first pair of legs beyond tip of rostrum about ·22 mm.

This is a varying but well-marked species, or else two closely allied species differing greatly from all others.

Colour varies through all shades of brown. Some specimens are black.

Shape short, pyriform, broad and rounded behind.

Texture.—Polished.

The principal characteristics are the great size and flexibility of the pteromorphæ.

Cephalothorax broad, bluntly-pointed, arched, *there are not any lamellæ or translamella.* Tectopedia rudimentary. Pseudo-stigmata far apart, lateral; the pseudo-stigmatic organs of all the very numerous specimens which I have found are long, mostly recurved, and lanceolate towards the ends, or almost filiform, but there is great variety. Interlamellar hairs long, straight, and fine. No well marked opisthophragmatic processes. Apodemata not reaching the sternum.

Nicolet draws and describes this species as having the pseudo-stigmatic organs short, clavate, and straight; differences in these organs are usually good

* *Alatus*, winged.

specific distinctions, but in this species the specimens certainly vary very much; I have not found any of the forms with the short organs, and Nicolet apparently did not find any with the long; Hermann's work does not show which he found. It seems improbable that this widely distributed species should be absent from either France or England. Nicolet gives Koch's *Zetes dorsalis*, which is a form with long organs, as a variety of his *alata*, although the variation Nicolet refers to is not the one here spoken of. Canestrini treats the specimens with the long organs as a separate species, viz. Koch's *climatus*. I have thought it best to treat both forms as varieties of one species; it may, however, be ultimately ascertained that there are really two. The size varies greatly. I found a very small variety in some numbers at Swanage in Dorsetshire. Koch relies greatly on size for his *climatus*.

Legs rather long and thin, tactile hairs upon the fourth as well as the first pair.

Abdomen almost circular, slightly narrowed anteriorly. Pteromorphæ very *large*, *flexible*, translucent, and light-coloured. *They project forward nearly to the tip of the rostrum, and have rounded anterior ends* when seen from above; the pteromorphæ have a strongly sinuated lateral margin, which is not visible from the dorsal aspect. Where the pteromorphæ join the progaster they leave deep indentations, through which the pseudo-stigmatic organs rise. The pteromorphæ contain a number of radiating irregular curved tubes or markings in the thickness of the chitin or between the two surfaces.

The female is sometimes seen with as many as ten fully-developed eggs in the oviducts at once, when, from the great size of the ova, the abdomen appears to be filled with them.

Nymph.

This nymph was known to C. L. Koch, who sup-

posed it to be the adult of a separate species and called it *Zetes satellitius* (Heft 31, pl. xiii).

Creature very broad, much arched on the back, highly polished, and transparent.

Colour varies from straw-colour to brown, a large central portion of the abdomen corresponding to the alimentary tract being dark, and the more marginal parts pale yellow-brown.

Cephalothorax very short. Rostrum bluntly conical, bearing two pairs of short, curved, fine hairs; one pair near the apex, the other on the dorsal surface. Behind the rostrum the cephalothorax suddenly widens, and its edge runs at a very obtuse angle to meet that of the abdomen; the two together, without the rostrum, being nearly circular, but slightly pointed posteriorly. Pseudo-stigmatic organs of medium length, dark, recurved, thin, and only slightly thickened towards the ends.

Legs rather thin and short for the massiveness of the creature, tibiæ very little longer than the genuals; the two front pairs of tibiæ bear the tactile hairs, not very long; all joints of all the legs bear a few short, fine, almost straight hairs.

Abdomen.—Progaster nearly straight, very broad, slightly pointed posteriorly. Notogaster very polished and quite hairless.

Distribution.—Generally distributed. The nymph is very powerful and moves fast; both it and the perfect creature are found in moss, usually on the ground, and in lichen.

The larva and nymph are easy to rear; they greatly resemble those of *O. globula*, but are smaller.

The species has been recorded in Sweden, Switzerland, Germany, France, Belgium, and Italy.

ORIBATA CUSPIDATA,* sp. nov., Pl. X, figs. 6—11; Pl. XXIV, fig. 1.

Average length about ·35 mm.
Average breadth about ·24 mm.
Average projection of first pair of legs beyond tip of rostrum about ·08 mm.

This minute species is closely allied to *Oribata femorata*, Nic. The principal distinctions are:—1st. That the femurs of the second pair of legs are not dilated at the anterior extremities, which is the great distinction of Nicolet's *femorata* (or *femoralis*, for he calls it sometimes by one, sometimes the other name). 2nd. That the pseudo-stigmatic organs are longer in the present species and are not recurved as in *femorata*; and, 3rdly, that the present species is very much smaller.

Colour light yellowish-brown (*femorata* is darker). Legs a little darker, pteromorphæ very light and sufficiently transparent to show the proximal joints of the second pair of legs through.

Texture polished in general effect, and reflects light in spite of being finely punctured when examined under a high amplification.

Size varies considerably.

Shape broad, rounded posteriorly (when the pteromorphæ are expanded to about the usual extent during motion). The cephalothorax is much narrower than the abdomen.

Cephalothorax.—*Rostrum* rather pointed, *genæ with strong points*, which show at the side of the frons, whence the name (Pl. X, fig. 8, *d*); rest of cephalothorax flattened on the dorsal surface, much hidden by the progaster. Lamellæ small, *very short*, doubly curved, without cusps, concave on the anterior margin; from the centre of this concavity springs the lamellar hair, which is strong and setiform. *No translamella.*

* *Cuspis*, the point of a weapon.

Tectopedia large, first pair *with projecting points;* a long setiform hair springs from the centre of the cavity within each first tectopedium. Pseudo-stigmatic organs longish, gradually increased in size towards the distal ends, blunt-ended if seen on the flat, shuttle-shaped if seen on edge; they point forward and outward. Interlamellar hairs long, setiform, perpendicular at first and then curving backward. Phragma large. Lateral opisthophragmatic processes square and set very far back.

Legs fine and thin, with numerous fine hairs.

Abdomen.—Progaster undulated; the central part, where it projects over the cephalothorax, rounded; it is sharply incurved above the pseudo-stigmata and curves outward again to form the anterior margin of the pteromorphæ. There is a raised linear border along the progaster. There are not any hairs on the notogaster.

The Nymph.

I doubt if it be possible to distinguish this nymph from those of one or two of the *Notaspides*, it varies considerably.

Colour white or pinkish-white (the figure is too pink), *very transparent;* the food in the alimentary canal shows plainly and gives colour. Legs and rostrum pinkish.

Texture polished, with a number of transverse marks, like scratches.

Shape long and narrow.

Cephalothorax.—Rostrum obtusely pointed. Palpi showing very plainly. Cephalothorax long and narrow, slightly constricted in the middle. Two pairs of rostral hairs. Pseudo-stigmata dorsal; pseudo-stigmatic organs long, slightly clavate, directed forward and outward. Interlamellar hairs short and spine-like.

Legs long and thin, tactile hairs on all the tibiæ;

fine curved hairs in a whorl on each of the three central joints of each leg.

Abdomen a long ellipse, truncated anteriorly. Progaster sinuated. Notogaster polished, *a strong spine* on each antero-lateral angle. Two rows of short hairs or spines on the notogaster near the edges, and a row of short curved hairs round the posterior margin; sometimes these are spines. The quality and size of all the hairs on the abdomen varies greatly.

Distribution.—The species is common and generally distributed. Moss is the chief habitat. Both adult and nymph, but especially the latter, are very active. The nymph is very common in May, but seems to be found all the summer.

ORIBATA LUCASII,* *Nic.* Pl. XI, figs. 1—5; Pl. XXIV, fig. 2.

Oribata Lucasii, Nic. P. 432, pl. iv, fig. 2.

Average length about ·6 mm.
Average breadth about ·4 mm.
Average projection of first pair of legs beyond point of rostrum about ·2 mm.

Nicolet puts a query as to whether this is not the *Zetes lævigatus* of Koch. I scarcely think that it can be, as the form of the stigmatic organs does not agree.

A rather slender species, having a strong affinity to the genus *Notaspis*. **Colour** usually light reddish-brown, legs and pteromorphæ lighter and yellowish. **Texture** highly polished.

Cephalothorax long, narrowed gradually toward the point of rostrum, which is sharp; the palpi show at the side. Lamellæ without cusps, or with only indications of them; each lamella is narrower towards the

* After M. Lucas, the French naturalist.

distal extremity, it is a blade standing nearly on edge, somewhat undulated, and terminated by a long, stiff, straight, lamellar hair; translamella absent or rudimentary. Pseudo-stigmata rather conspicuous. *Pseudo-stigmatic organs with fusiform heads borne upon long, slender peduncles*, and recurved over the back. Inter-lamellar hairs long, flexible, setiform. Rostral hairs long and curved. The shelf which carries the first pair of legs is conspicuous. Lateral opisthophragmatic processes small, curved, and sharp-pointed; central ones very small. Apodemata joined to the sternum.

Legs long and slender; first two pairs about equal length, and having blades on the edges of the femurs, which blades are small on the first pair, but very large and rounded on the second, where they bear a hair; there are tactile hairs on the tibiæ of all the legs, those on the first pair are very long; there is also a smaller similar hair on the genual of each leg of the first two pairs, and a whorl of longish curved hairs on each joint of each leg. Tarsi thickly clothed with fine hairs, a few other scattered hairs.

Abdomen oval, rather long, arched, but flattened on the central part of the notogaster. Progaster slightly sinuous. Pteromorphæ small, very transparent. There are not any hairs on the notogaster, but a few very short ones are seen projecting round the hind margin. Ventral plate much embraced by the dorsal at the sides; genital plates almost heart-shaped, and placed far forward. Anal plates large, almost square.

Nymph.

Very like a *Notaspis* nymph.

Colour white, very transparent; internal organs show plainly; legs and rostrum pink.

Texture smooth, polished.

Cephalothorax long, slightly constricted in the middle; rostrum rounded but with a small point.

Two pairs of rostral hairs, hinder pair the larger. Palpi showing. Pseudo-stigmata rather dorsal. Pseudo-stigmatic organs long, with fusiform heads on slender peduncles directed forward. Inter-lamellar hairs setiform, moderate length.

Legs with the two front pairs of femurs enlarged; fourth pair of legs hardly reaching the hind margin.

Abdomen long, narrow, of almost equal width throughout, hind margin rounded. Progaster nearly straight, slightly convex. Notogaster hairless and without markings, a fine hair on each antero-lateral angle and a few very short ones on hind margin.

Distribution.—Species common and generally distributed, but difficult to distinguish from some others until carefully examined. It has been recorded in France.

ORIBATA AVENIFERA,* sp. nov. Pl. XI, figs. 6—11; Pl. XXIV, fig. 3.

Average length about ·32 mm.
Average breadth about ·25 mm.
Average projection of first pair of legs beyond tip of rostrum about ·11 mm.

A small species.

Colour reddish-brown, not very dark.

Form approaching globular when the pteromorphæ are pressed to the body, more shield-shaped when these organs are extended.

Texture appears highly polished under a moderate power, under a higher one it is very finely punctured. The general effect under a low power is of a little, brown, polished bead.

Cephalothorax short and broad, much overhung by progaster. First tectopedium very bulbous at the proximal end, and carried far forward. Lamellæ

* *Avena*, an oat; *fero*, I carry.

long, narrow blades on edge. Cusps long, blunt; lamellar hairs terminal, curving slightly inward. *Pseudostigmatic organs the shape of oats* (whence I have derived my name for the species), and highly granular; they are sessile and *almost horizontal, pointing forward and slightly inward.* Interlamellar hairs strong and setiform. Rostral hairs are not observable.

Legs stout, curved. Tibiæ wide at distal end; in fourth pair this forms a projecting process (fig. 11). Tactile hair much developed on first pair of legs, and present on the tibiæ and genuals of all the legs, joints otherwise sparsely haired, except tarsi, on which the larger hairs form a series standing up along the superior central line.

Abdomen.—Progaster advancing greatly in the centre; very round posteriorly. Notogaster much arched, hairless. Pteromorphæ shortish, but usually carried a good deal extended.

Distribution.—I have found the species in moss at the Land's End, Cornwall; at Swanage in Dorset; Dorking, Surrey; and in other places. It is not very common.

I am not acquainted with the immature stages.

ORIBATA PARMELIÆ,* sp. nov. Pl. XII, figs. 1—5.

Average length about ·42 mm.
Average breadth about ·25 mm.
Average length of legs (first pair) about ·17 mm.

A small species not possessing any remarkable features except the monodactyle claw.

Colour dark chitinous-brown.

Texture smooth but not quite polished, it catches the light strongly, but is thickly and irregularly marked with small punctures and short impressed lines. Cephalothorax short, conical. Rostrum blunt. *La-*

* *Parmelia* (*Fissia*), a genus of lichens.

mellæ, very long blades, nearly on edge; cusps long, bearing a stout curved hair which springs a little below the point. Translamella a thickened line. *Pseudo-stigmatic organs short, pyriform, recurved.* Inter-lamellar hairs long, stout, setiform. Lateral opistho-phragmatic processes large, square; central ones small, but very well marked, close together. Apodemata not reaching the sternum.

Legs of moderate length, the hind pair about reaching the posterior margin. The genuals of the two first pairs of legs are remarkable for the size of their distal extremities, which are produced so as almost to form curved points. *Claws monodactyle.* The tactile hair is on the first pair only, most joints bear a whorl of fine curved hairs.

Abdomen almost elliptical. Progaster very convex; a sharp, narrow indentation at the commencement of the pteromorphæ, caused by the form of these organs, which are short but rather broad, and curve forward after springing from the progaster; they are translucent. There is a row of long, fine, rather distant, flexible hairs round the margin of the notogaster, and two longitudinal rows of smaller similar hairs nearer the median line. Genital plates placed far back.

Nymph.

Colour: whenever I have caught it, this nymph has been bright orange-yellow, passing into gamboge-yellow in high light, or when seen by transmitted light, and having a slightly brown shade over the central part of the notogaster. Legs much the same colour but lighter. This colour is probably due to the fact that all the specimens which I have captured have been feeding upon yellow lichen. It may be that the food produces the colour, or it may be that the colour is a special protective provision and is irrespective of the food; I am not able to say what would be

the colour if found feeding on anything else, nor, indeed, can I say that it ever is so found. In either case the colour would serve it well to escape detection.

Cephalothorax short, obtusely conical, a considerable protuberance at each pseudo-stigma, these are wide apart; pseudo-stigmatic organs short, strongly clavate (or pyriform). Interlamellar hairs long, robust, setiform. Rostral hairs longer than usual, nearly straight. There are two pairs of graduated, setiform hairs on the dorso-vertex, between the rostral and interlamellar.

Legs short, stout, usually much curved; the fourth pair is seldom visible from the dorsal aspect. Both the first and second pairs have tactile hairs, the other hairs on the legs short and rather sparse.

Abdomen in form like a short sack, the sides almost parallel, and the hind margin rounded; it is much arched, and is divided about the middle by a conspicuous transverse cut or trench, the margin of which is dark. Progaster convex, there are two or three short folds springing from the anterior part of the lateral margin, and running only partly across the body, more or less parallel to the progaster. There are also usually several irregular indentations about the body, which vary in different specimens, and in the same specimen at different ages, and even on the two sides of the body. Two long, flexible, setiform hairs on each antero-lateral angle, about six similar round the hind margin, and a row of shorter hairs down each side of the notogaster about midway between the lateral margin and the median line. The size and length of all the hairs varies considerably in different specimens. This nymph is very sluggish.

Distribution.—I have only found the species near the Land's End, Cornwall, feeding upon the golden lichens, *Parmelia* (*Fissia*) *parietina*, which grow so luxuriantly on the granite rocks of the sea cliffs.

ORIBATA FUSIGERA,* sp. nov. Pl. XII, figs. 6—11.

Average length ♀ about ·3 mm.
Average breath ♀ about ·2 mm.

An extremely small species

Colour almost black, front part of abdomen brown, legs lighter.

Cephalothorax.—Rostrum short and fine, cephalothorax small, overhung by progaster. Lamellæ nearly on edge, short, near together, often almost hidden by the pseudo-stigmatic organs. No translamella. *Pseudo-stigmatic organs long, fusiform, terminated by a fine hair* as in some species of *Leiosoma;* they point forward, inward, and upward. No interlamellar hairs. Tectopedia long and concave, forming deep depressions for the legs.

Legs of moderate length, rather thick, hairs fine and scattered, *claws monodactyle*, rather small and open. A whorl of short curved hairs on most joints.

Abdomen.—Progaster strongly sinuated. Pteromorphæ usually carried close to the body. Notogaster polished, without hairs or markings. Genital plates pentagonal, almost as large as the anal.

Nymph.

Colour pale-clăret or pinkish. **Texture** not polished, rather coarsely punctured all over. General **shape** long pyriform.

Cephalothorax.—Rostrum small, long, narrow, distinctly marked off from the remainder of cephalothorax. Palpi showing from dorsal aspect. Hinder part of cephalothorax much wider. Pseudo-stigmatic organs fusiform on slender peduncles.

Legs rather short, hind pair much shorter than the abdomen.

* *Fusus*, a spindle; *gero*, I carry.

Abdomen almost shield-shaped, pointed posteriorly, truncated anteriorly, widest about two-thirds of its length from the progaster. Not much arched. Notogaster without hairs.

Distribution.—The creature is found in moss, including dry sphagnum; I have found it at Epping; Dorking (Surrey); and Swanage (Dorset). It is not uncommon. I have bred it in confinement through two or three generations, and found that the eggs were laid in or on grass stems, into which the larvæ and nymphs burrow; they seldom leave the stem, but are active when separated from it.

Sub-family.—Apterogasterinæ.*

Oribatidæ without any chitinous wing-like expansions to the abdomen (pteromorphæ).

This sub-family contains all the *Oribatidæ* except the genera *Pelops* and *Oribata*. It is clearly differentiated by the absence of the pteromorphæ. In *Notaspis* and *Leiosoma*, however, the antero-lateral angles of the abdomen are produced, and form a chitinous shelf which gives some indication of a step towards pteromorphæ.

The genera composing the *Apterogasterinæ* vary greatly; they may be divided into two tribes, one in which the abdomen is firmly attached to the cephalothorax, the other where they are articulated by a ginglymous joint allowing free movement. The former tribe consists of eleven genera, viz. *Serrarius*, *Leiosoma*, *Cepheus*, *Scutovertex*, *Tegeocranus*, *Notaspis*, *Damæus*, *Hermannia*, *Eremæus*, *Nothrus*, and *Hypochthonius*. The latter consists of one genus only, *Hoplophora*.

* A, without; πτερὸν, a wing; γαστὴρ, the stomach.

No general rule can be given for the *Apterogasterinæ*, or even for the first tribe; on the whole their construction is simpler than that of the *Pterogasterinæ*. The first tribe might be separated into two parts, viz. one where the cuticle of the adults does not become wholly chitinised, and where the adult resembles the nymph, which would include the genera *Nothrus* and *Hypochthonius*; and the other where the cuticle of the adult is fully chitinised and the adult is usually different from the nymph, this would include the other nine genera.

Genus—SERRARIUS,* *Michael*.

Apterogasterinæ with cephalothorax anchylosed to abdomen. With lamellæ. The last three pairs of legs articulated under the body. Tridactyle claws. Mandibles rod-like and serrated, not chelate.

The definition of this genus would be equally efficient if all between the name of the sub-family and the description of the mandibles were omitted. I have given the intermediate part for the sake of uniformity.

I am only acquainted with one British species, or, indeed, with one species anywhere, but probably the mandibles of foreign members of the family have not been properly examined.

The one known species was always supposed to be a *Leiosoma* (*Cepheus*) until I dissected the mouth organs. As these, although so very exceptional, constitute the only distinction from *Leiosoma* which I am acquainted with, I do not think that it would be useful to enter into a long description of the genus, but will rather refer the reader to that of the genus *Leiosoma*, which will be found to apply, *except as to the trophi*. These are as follows:

The **Labium** is very short, much wider than long, with a concave anterior margin. It does not above

* *Serrarius*, a sawyer.

one-third close the long-shaped opening of the camerastomum; it is, however, continued anteriorly by a large membranous lingua, the central portion of which forms a sucking tube, so that, when dissected out and seen from within, the two organs together present the appearance shown at Pl. XIV, fig. 11. The front part of the lingua is provided with two stout spines.

The **Palpi** stand almost free from the labium, but are not seen from the dorsal aspect; they have the usual short basal joint, the second incrassated and longer than the succeeding two, the third and fourth shortish, and the terminal joint fusiform.

The usual **Maxillæ** are entirely absent or rudimentary, which is not the case in any other genus in the family that I am acquainted with.

The **Mandibles** constitute the great distinction of the genus. They are quite different from anything else in the family except a general resemblance in form to those of *Pelops*, which must be considered far nearer to them than any other mandibles in the *Oribatidæ*. In *Serrarius* they are shaped like broad-bladed axes with long, curved handles, the blade being the inner part containing the muscles, &c., and the handle the distal portion of the organ. This rod-like portion ends in a point distally, and for about one-third of the length from the point backward is finely serrated on its lower (concave) edge, with closely-set, recurved teeth of regular size. The mandibles and the lingua appear to form a sawing and sucking mouth different from that of other genera.

The *apodemata* in *Serrarius* are not joined to the sternum, they resemble those of *Leiosoma* (*Cepheus*) *palmicinctum*. The anal plates are small and roundish.

SERRARIUS MICROCEPHALUS* (*Nic.*). Pl. XIV, figs. 7—13.

Type species.

Leiosoma microcephala, Nic. P. 443, pl. vi, fig. 4.
Serrarius microcephalus, Michael. Journ. Royal Microsc. Soc., Feb., 1883, p. 25.

Average length about ·45 mm.
Average breadth about ·35 mm.
Average length of legs (first and second pairs) about ·20 mm.
Average length of legs (third and fourth pairs) about ·30 mm.

The only species of this genus yet known.

Colour rich red-brown, legs lighter.

Texture highly polished, whole effect almost globular, like a small bead.

Rostrum rather blunt, slightly trilobed, two longitudinal chitinous ridges on its dorsal surface, terminating in the rostral hairs, which are rather long.

Cephalothorax very short in proportion to the abdomen. Lamellæ blades nearly on edge, widest anteriorly; cusps rather long, slightly truncated; lamellar hairs terminal. Translamella a thickened bar; pseudostigmata far apart, almost hidden; pseudo-stigmatic organs very long, with long slender peduncles and small fusiform heads terminating in a curved point. Interlamellar hairs long and setiform; first tectopedium blade-like, well developed, second almost obsolete.

Legs rather long. Femurs enlarged, no blades; tibiæ and tarsi long and slender, tactile hairs to two front pairs; hairs on all joints fine and flexible, rather long.

Abdomen almost circular, much arched, not very distinctly divided from cephalothorax. Progaster slightly rounded, notogaster polished, without hairs or markings, three pairs of fine short hairs round poste-

* Μικρὸς, small; κεφαλὴ, the head.

rior margin. Genital plates broader than anal, and broader than long, placed far forward; anal plates small.

Distribution.—I have found the species at Epping Forest, the Land's End (Cornwall), and Swanage (Dorset). It is rare. It has been recorded in France and Germany (Württemberg, by Haller).

I am not acquainted with the immature stages.

Genus—LEIOSOMA,* *Nicolet.*

Equals part of *Oribates*, Koch.

Apterogasterinæ with cephalothorax anchylosed to abdomen. With lamellæ. The last three pairs of legs articulated under the body; tridactyle claws. Chelate mandibles. Division between cephalothorax and abdomen unbroken; lamellæ small and abdomen smooth.

The name *Leiosoma* as stated in Chapter V, has been used by Kirby, and in Stephens' catalogue, in 1831, for a genus of *Coleoptera* before Nicolet adopted it for the present genus; probably, therefore, I ought to abandon it, but were I to do so I should not be inclined to separate this genus from *Cepheus*, as Nicolet's distinctions between the two break down on further knowledge; but I have, on the whole, for reasons given in Chapter V, thought it is best not to drop the name, particularly as, although there does not seem any sufficient structural difference, the general appearance is unlike in the two groups. I have retained the name, leaving those who think that the rule against duplicate names should be strictly observed, to use that of *Cepheus*.

All known species of *Leiosoma* are polished or smooth, never rough. The most typical forms are long-shaped and rather diminished posteriorly. All

* λεῖος, smooth; σῶμα, a body.

have the notogaster arched, and the abdomen large in proportion to the cephalothorax. They are usually black or exceedingly dark brown.

The **Rostrum** is usually moderately fine with a rounded point; the cephalothorax small, and considerably less wide than the progaster.

The **Labium** is usually rather short, closing about half of the camerastomum, and having a more or less convex anterior margin (Pl. XXIV, fig. 9).

The **Palpi** are generally nearly cylindrical and long, usually visible from the dorsal aspect; the first, third, and fourth joints of about equal length, the second almost as long as the following three, but not much incrassated; the fifth conical and with numerous fine hairs.

The **Maxillæ** (Pl. XIII, fig. 11, *d*) are well developed, each usually consists of two bifid lobes, the outer being the larger.

The **Mandibles** are of the normal form, and usually quadridentate.

The **Lingua** (Pl. XIII, fig. 11, *g*) is ordinarily well developed but not especially so.

The **Pseudo-stigmata** are generally inconspicuous, and wholly, or partly, hidden by the advancing antero-lateral angle of the abdomen.

The **Interlamellar hairs** in the known British species are setiform or absent.

The **Lamellæ** are distinctly developed in all known British species. They are narrow, straight blades on edge, and usually approach near together anteriorly, so as to enclose a more or less triangular dorso-vertex.

The **Tectopedia** are present, but are not large; the first pair have not any free anterior projection, as is so commonly the case in *Oribata*, &c. The lateral opisthophragmatic processes are of medium size and rounded; there is not any central process.

The **Legs** are rather long and slender. The two hind pairs have the coxæ and femurs broad and flat, and with large blades; the genuals minute; the tibiæ

and tarsi long and very slender. The two front pairs have not the flattened coxæ nor femurs, and the other distinctions are less marked. All the legs are terminated by tridactyle claws; the central unguis is much the largest.

The legs of the last three pairs are received in shallow depressions of the sternal or ventral plate; one such depression on each side receives the second and third legs, which are inserted close together, another the fourth leg, which is some distance from the third.

The **Apodemata** usually reach to the sternum, but that is not the case with all those of *palmicinctum*, which, in many respects, is far from a typical species.

The **Genital Plates** are usually small and set far forward; the anal large and more or less quadrangular.

The **tracheal** system is fully developed. The **cæca** of the ventriculus are usually short and round. The **ovipositor** very long.

The adults are found in moss, lichen, and often abundantly in fallen gorse-needles.

The larvæ and nymphs vary greatly, no general rule can be given regarding them.

The genus is doubtless most nearly allied to *Cepheus*, but presents many points of analogy to *Notaspis* and *Oribata*.

I only know of three British species, some authors would doubtless divide at least one of these (*simile*) into two species.

Table for identifying British species of Leiosoma.

Abdomen oval and elongated	Pseudo-stigmatic organs fusiform with a terminal hair	*Simile.*
	Pseudo-stigmatic organs short and clavate	*Ovalum.*
Abdomen almost round		*Palmicinctum.*

Leiosoma simile,* *Nic.* Pl. XIII, figs. 1—7; Pl. XXIV, figs. 4 and 9; Pl. E, fig. 14; Pl. F, fig. 11.

Type species.

Leiosoma similis, Nic. P. 442.

Average length about ·85 mm.
Average breadth about ·51 mm.
Average length of legs, (1st pair) about ·33 mm.

Colour is very dark chitinous-brown. **Texture** very polished.

Rostrum pointed with a small mucro on each side.

Cephalothorax considerably narrower than the progaster.

Dorso-vertex narrow, almost triangular, raised in the middle, leaving a narrow, depressed space bordering the inside of each lamella; the raised central portion is broad and rounded posteriorly, but terminates anteriorly in a thin cone, the point of which is free and projects a little beyond the lamellæ; in some specimens this point is very sharp, in others it is more square. Lamellæ large blades, widest posteriorly, slightly sinuate; they approach very near together at their anterior ends, which are deeply indented, so as to terminate in two free, curved points, of which the lower and inner is the longer. The lamellar hair is a strong spine, which springs from between these two points, and extends beyond the tip of the rostrum. Pseudo-stigmatic organs *fusiform, sessile, terminated distally by a fine hair.* Interlamellar hairs long and setiform; there is another pair of smaller hairs on the dorso-vertex. Tectopedia large, and plainly visible from the dorsal aspect, apodemata strong, and joined to the sternum.

Legs thin, only the first pair have the tactile hair; the fourth do not nearly reach the posterior margin.

* *Similis*, like.

There are blades to all the femurs; numerous fine hairs, chiefly arranged in whorls.

Abdomen a very long and rather elegant ellipse, truncated anteriorly, but with a slight tendency to be pointed posteriorly. The progaster greatly overhangs the cephalothorax, particularly at the lateral angles, where it entirely conceals the pseudo-stigmata. Notogaster highly polished, hairless, much arched. Genital plates small, heart-shaped, set far forward. Anal plates very large and square, reaching the hind margin.

Nymph.

Almost **Colourless**, very slightly pinkish; semi-transparent; tips of rostrum and tarsi darker.

Texture polished. General form oblong.

Rostrum blunt, palpi showing plainly.

Cephalothorax broad. Pseudo-stigmata dorsal; pseudo-stigmatic organs short, fusiform. Interlamellar hairs short; a second pair of hairs nearer together and more forward.

Legs rather short, thick; tactile hairs large, a whorl of fine curved hairs on each of the three central joints of each leg.

Abdomen oblong, with a small, posterior, central point. Progaster straight or slightly concave; notogaster polished, with a row of long, flexible, sparsely-set hairs round the margin.

Distribution.—The species is abundant and generally distributed; it is found in moss, and in considerable numbers in the débris under furze-bushes. I had great difficulty in tracing the larvæ and nymphs, and sought for them in vain for a long time; at last I discovered that they bored into the furze-needles and lived in the interior; of course they may do so with other plants also, but I have not found them elsewhere.

The species has been recorded in France.

I have found a large variety of this species, in

several places, about a third larger than the ordinary form; but, as I cannot find any other difference, either in nymph or adult, I treat it as a variety only.

LEIOSOMA (CEPHEUS) OVATUM, (*Koch*). Pl. XIII, figs. 8—14; Pl. XXIV, fig. 5.

Oribates ovatus, Koch. Heft 30, fig. 24.
Leiosoma ovata, Nic. P. 443, pl. vi, fig. 5.
— *truncatum?* Can. e Fan. Atti Soc. Ven. Trent. di Sci. Nat., vol. v, fas. 1.

Average length about ·65 mm.
Average width about ·40 mm.
Average length of legs (first pair) about ·30 mm.
Average length of legs (fourth pair) about ·40 mm.

Colour of English specimens varies from rather pale yellow-brown to chestnut-brown; Nicolet calls it dark brown, Canestrini and Fanzago speak of yellow-brown for the peripheral part of the abdomen of their *L. truncatum*.

Texture smooth, but not polished, dull, and finely punctured all over; this agrees with Canestrini and Fanzago rather than Nicolet. General **form** oval, rather broader in proportion than *simile*, and a trifle more pointed posteriorly.

Rostrum rather blunt, and with a slight tendency to be trifid. Palpi showing. Dorso-vertex less triangular than in *L. simile*, and *not forming any median point*. Lamellæ broad blades, nearly on edge, of about even width throughout, not approaching so near together anteriorly as in *L. simile;* truncated anteriorly, *no cusps, nor indentation* of the truncated edge. Lamellar hairs spring from bottom of truncated edges. Rostral and lamellar hairs very slightly imbricated if seen by a high power; no translamella. Pseudo-stigmata just visible from the dorsal aspect; pseudo-stigmatic organs *very short* and strongly clavate, sometimes almost globular. Interlamellar hairs short and setiform, tectopedia large, plainly visible from dorsal

aspect. Lateral opisthophragmatic processes large, rather square; median processes small, close together.

Legs long; hind pairs thin; coxæ of fourth pair pointed at the upper distal angle. Femurs with blades. Tactile hairs to all legs; a whorl of fine hairs on each of the three central joints, hairs on the tarsi long.

Abdomen almost elliptical, sometimes slightly pointed posteriorly, not much arched. Progaster convex, sometimes with a slight median indentation, not overhanging the cephalothorax. Two rows of fine hairs on notogaster, and another row round the margin, chiefly seen near the antero-lateral angle and posterior margin; these hairs are not so large, nor the marginal and central rows so near together, as in Nicolet's drawing. Genital and anal plates widely separated, the former small and heart-shaped, the latter large, square, and reaching the hind margin.

The English specimens are rather more like Canestrini's *truncatum* than Nicolet's *ovata;* I can hardly think that these are distinct species; the main distinction of a truncated anterior, from which the name is taken, is possibly due to the extent to which the mandibles are protruded; it is a common appearance with many species. Probably many authors would consider the creatures distinct; I am averse to founding species on very small distinctions alone.

Nymph.

It is very difficult to distinguish this nymph from those of *L. simile* and *Cepheus tegeocranus*, they are very much alike.

Almost **Colourless**, very slightly pinkish; tips of rostrum and tarsi a little darker, semi-transparent. General **Shape** rather pyriform, but not far from oblong.

Rostrum not very blunt, palpi showing. Cephalothorax broad. Pseudo-stigmata dorsal; pseudo-stigmatic organs short, clavate. Interlamellar hairs long.

Legs rather short and thick. Tactile hairs large, a whorl of fine hairs on each of the three central joints of each leg.

Abdomen oblong, rounded posteriorly, with a small posterior central point. Progaster straight or slightly concave; notogaster polished, with a row of long, flexible, sparsely-set hairs round the margin.

Distribution.—The species is common and generally distributed; it is found in moss, and in great quantities in the débris of furze-bushes. I once, in spring, put several adults in a cell alone; I gave them some furze-needles which did not show any sign of perforation, in June I found several larvæ in the needles. If any of these wood-boring forms are long exposed they die: great care is necessary in searching for them as they are easily injured.

The species has been recorded in France, Germany, and Italy.

I found a small variety at Swanage, Dorset, nearly one-third smaller than the usual measurement. I bred from it, but the immature stages were like those of the larger form, except in size.

LEIOSOMA (CEPHEUS) PALMICINCTUM,* *Michael.* Pl. XIV, figs. 1—6; Pl. XV, figs. 1—6; Pl. XXIV, fig. 6; Pl. D, fig. 16; Pl. E, figs. 8—10; Pl. F, figs. 12, 13; Pl. G, figs. 7—9.

Leiosoma palmicinctum, Michael. Journ. R. Microsc. Soc., vol. iii, p. 184, pl. III.

Average length about 1·02 mm.
Average breadth about ·72 mm.
Average length of legs (first pair), about ·50 mm.
Average length of legs (second pair), about ·42 mm.
Average length of legs (third pair), about ·58 mm.
Average length of legs (fourth pair), about ·66 mm.

* *Palma*, a palm-tree; *cinctus*, girdled.

Colour very dark brown.

Texture smooth, but not polished.

Rostrum blunt, rostral hairs rather long, straight.

Cephalothorax broad, shortish. Lamellæ rather narrow, slightly undulated, blades on edge, marked with a few longitudinal wavy lines; cusps small, but rather long; lamellar hairs terminal, at the upper corner of the cusp, setiform. Translamella very distinct, forming a ridge. Pseudo-stigmata almost or quite hidden by the lamellæ and progaster. Pseudo-stigmatic organs of medium length, peduncles thereof very thin; the head has a tendency to be lanceolate if seen from the side. Interlamellar hairs large and setiform, standing upright. Tectopedia plainly visible from the dorsal aspect; opisthophragmatic processes very small, hardly developed; anterior apodemata joined to the sternum. Sternum serrated when seen with a highish power.

Legs rather long and thin, particularly the hind ones; a whorl of fine, almost straight hairs, at the distal end of each joint except tarsi. Hind femurs broad and thin, with blades, and having the antero-inferior angle almost a point. Three distal joints long and thin; a few of the hairs, particularly on the tarsi, are seen to be slightly pectinated if examined with a power of, say, 200 diameters.

Abdomen *almost circular*, slightly truncated posteriorly, without markings; it bears a pair of very fine hairs on the ventral edge of the hind margin. Ventral plate considerably smaller than the dorsal, which is reflexed at the posterior margin so as to meet the ventral. Genital and anal plates large and near together, the former almost square, the latter much wider posteriorly than anteriorly.

Nymph.

This is probably the most beautiful and interesting creature among the *Oribatidæ*. It carries the cast

notogastral skins, which form concentric rings on the back; each skin being bordered by a closely-set row of large scales, the whole dorsal surface, except the larval skin, consists of concentric ovals of these beautiful scales. The adjacent scales in each row. overlap, and each row overlaps the row outside it; the outer row is so large that it entirely hides the cephalothorax and the legs. The scales are iridescent, and the whole creature looks more like a flower than an Acarid.

Rostrum blunt; cephalothorax broad, short, and conical, almost without markings; rostral and inter-lamellar hairs short and setiform.

Legs short, of about equal thickness throughout, but joints irregular shaped. Tarsi conical, thickly covered with hairs, each hair springs from a small apophysis; a pair or more of serrated hairs, similarly inserted, is found at the distal end of each other joint.

From the dorsal aspect neither legs nor cephalo-thorax can be seen except from the transparency of the scales.

Abdomen elliptical, major axis about half as long again as the minor in the larva, but the two nearly equal in the fully-grown nymph. The edge of the ellipse is not even, but is concave between each pair of apophyses (mentioned below). The centre of the notogaster is covered by the larval skin, which is arched and covered with small, waved, transverse lines or wrinkles, very minutely dotted. The margin of this skin is slightly raised. The nymphal skin, where not covered by the larval, is finely reticulated. Round the margin are twenty apophyses; the eight anterior rather crowded together, the others more evenly distributed, but those at the sides farthest apart. Sixteen of these apophyses are more or less expanded at the base, and generally have three points; the lateral ones thin, flat, sharp, but often abortive; the central stout, cylindrical, truncated, and carrying a remarkably large scale, of the shape of a Japanese fan, or like the scale of the Lepi-

dopterous species *Lycena argus* or of *Lepisma saccarinum*, but broader. The apophysis is inserted like the petiole of a cordate leaf, and is expanded so as to form a hammer-head within the scale; this head is colourless (the rest of the apophyses being brown); from it radiate about sixteen black nervures, joined by a colourless membrane, which, however, diffracts light and assumes prismatic colours in sunlight. The two central nervures run almost straight to the distal margin of the scale; those at the edge follow the cordate shape of the proximal margin, and terminate near the distal end of the lateral margin. The nervures between these two extremes are intermediate in form. The longitudinal nervures are crossed by finer transverse nervures, which gradually become more delicate and closer together as they approach the distal margin. They are tolerably regular in the centre of the scale, but become broken and irregular toward the edges. Their general effect is to divide the scale into reticulations, which are nearly triangular at the proximal margin, square in the centre, and oblong elsewhere. One of the scales is shown in Pl. XV, fig. 3. The scales all slope downward slightly from the edge of the skin so as to touch the surface upon which the creature is resting.

When the nymph has just emerged from an ecdysis its own row of scales is almost hidden beneath that previous skin; as it grows, its own scales gradually protrude, until they finally stand nearly free of the previous row. The whole notogaster, except the larval skin, is covered by the scales; which, when the nymph is fully grown, project on each side about a third of the width of the real body.

The four apophyses which do not carry scales are longer than the others, especially the front pair; each terminates in an imbricated hair of singular size and length, the hind pair being sometimes as long as the whole body. These hairs break off from the cast skins.

The ventral surface is leathery and corrugated; the legs are set far in. The genital and anal plates touch; the latter are extremely long and narrow in form.

The **Larva** is, of course, like the larval skin above described, with a single border of scales; there is a similar scale, and two narrower curved ones on each of the legs of the first pair; the tactile hairs are serrated; the cephalothorax and legs show plainly.

Egg long-shaped, dark, chitinous, it has a deutovium stage.

Distribution.—I have only found the creature at the Land's End, Cornwall. The nymph and larva are found on *Peltigera canina* and other closely allied lichens; they stop on the under side of the frond and scarcely move. (Pl. XIV, fig. 3.) The adult is of a more wandering disposition. It has not been recorded elsewhere.

Genus—CEPHEUS,* *Koch.*

Apterogasterinæ with cephalothorax anchylosed to abdomen; with lamellæ; the last three pairs of legs articulated under the body; tridactyle claws; chelate mandibles; division between cephalothorax and abdomen unbroken; lamellæ large and light-coloured; abdomen rough.

All known species of this genus are rough and unpolished; either coarsely reticulated (Pl. C, fig. 12) or covered with large dots irregularly scattered, or with depressed pits arranged in a regular pattern (Pl. XVI, fig. 1). The ventral surface also is usually rough with impressed pits or reticulations. The body is usually broad, somewhat less arched on the notogaster than in *Leiosoma*, but the ventral plate a good deal rounded. The progaster is generally somewhat concave, and the antero-lateral angles produced for-

* Nom. propr. The father of Andromeda.

wards, as though a slight tendency to pteromorphæ existed.

The **Rostrum** is usually very blunt, the cephalothorax broad and large, nearly as wide as the progaster.

The **Labium** is wide and rather short, covering about half of the camerastomum (Pl. XXIV, fig. 10). It often has a small median point (Pl. XVII, fig. 3, *f*) otherwise it is nearly straight anteriorly.

The **Palpi** are cylindrical, the second joint very much the longest but not much incrassated (Pl. XVII, fig. 5, *e*). The terminal joint is also long and with the usual hairs.

The **Maxillæ** are large and rather simple, but with the upper lobe often forming a powerful rounded tooth (Pl. XVII, fig. 5 *d*).

The **Mandibles** are generally short, with the chelæ large and quadridentate, but they vary somewhat in *ocellatus*.

The **Lingua** is not usually much developed.

The **Pseudo-stigmata** are large and generally open on the extreme lateral edge of the cephalothorax, those of *ocellatus* are most remarkable and are the leading distinction of the species.

The **Interlamellar hairs** vary much, and form good specific distinctions.

The **Lamellæ** are the great mark of the genus; they are very large, forming great undulating blades, always considerably lighter in colour than the rest of the body, and often widest anteriorly; in the typical species they approach close together anteriorly, so as almost to touch, indeed, they sometimes actually do so; the dorso-vertex enclosed by them is then truly triangular. It was the species of this genus, from the great size of the lamellæ, and the appearance of elevation which they communicate to the dorso-vertex, that deceived Nicolet into the idea that there was a tectum attached by its base only. The lamellæ are never upright, they are usually sloping, but may be almost horizontal

(*ocellatus*). A section through the lamella of *Cepheus* to show the true formation is depicted at Pl. C, fig. 16.

The **Tectopedia** attain as high a degree of development in this genus as in any; they are really outfoldings of the cuticle of the same nature as the lamellæ, and it would seem as though the two organs were correlated, both being so large in the same creatures. The first tectopedium is a large blade-like organ running parallel to, and below the lamella, on each side. It is continued to the end of the rostrum. The second tectopedium forms a great chamber, somewhat elliptical in form, in the anterior part of which the coxa of the first leg is articulated, and which can receive and conceal the whole coxa and femur of that leg.

The **Legs** are rather long and thin in the typical species; the two hind pairs of coxæ and femurs are not flattened nor provided with blades as in *Leiosoma*, although some slight remains of the blade may be seen at the distal end of the femur; the tibiæ of the same legs are very long and fine. The legs of *ocellatus* are thicker and shorter, and have not the slender hind tibiæ, but, as before stated, this is not a normal species. The claw is tridactyle, usually as near an approach to a homodactyle claw as exists in the family (Pl. XVI, fig. 7). In Pl. XVII, fig. 11, the lateral claws are not quite curved enough, which makes them look too heterodactyle. Those of *bifidatus*, however, are strongly heterodactyle.

The sternal and ventral plates have two shallow excavations on each side for the reception of the last three pairs of legs; the fourth pair is not set so far from the third as in *Leiosoma*.

The **Apodemata** are chiefly joined to the sternum, but a short one, really belonging to the fourth pair of legs, generally stops before reaching it.

The **Genital Plates** are chiefly small, and rounded or square; the anal large and quadrangular.

The **Tracheæ** are fully developed. The **Ovipositor** is moderately long.

The adults are usually found in moss or lichen.

The genus is most nearly allied to *Leiosoma*, but has many points of resemblance to *Tegeocranus*, particularly *T. latus*.

I know of four British species; probably many authors would institute a new genus for one of these, *ocellatus*.

Table for identifying British Species of Cepheus.

Pseudo-stigmatic organs almost globular and sunk actually *in* the pseudo-stigma; markings on the notogaster double rows of alternate pits, with a ridge between each double row . . .	*ocellatus.*
Pseudo-stigmatic organs projecting from the pseudo-stigmata; markings on notogaster irregularly scattered:	
Claws heterodactyle; lamellæ separated anteriorly by a deep cleft	*bifidatus.*
Claws almost homodactyle; lamellæ almost touching anteriorly: pseudo-stigmatic organs long, straight, and clavate; interlamellar hairs large and rod-like	*tegeocranus.*
Claws almost homodactyle; lamellæ almost touching anteriorly: pseudo-stigmatic organs short, recurved, almost pyriform; interlamellar hairs absent or extremely minute . .	*latus.*

CEPHEUS OCELLATUS,* *Michael.* Pl. XVI, figs. 1—7.

Cepheus ocellatus, Michael. Journ. R. Microsc. Soc., ser. ii, vol. ii, p. 1.

Average length about ·6 mm.

Average breadth about ·32 mm.

Average length of legs (first, second, and third pairs) about ·24 mm.

Average length of legs (fourth pair) about ·32 mm.

A singular and well-marked species, not to be mistaken.

Colour very dark brown, often almost black.

Texture dull, without the slightest gloss.

* *Ocellus*, a little eye.

Rostrum sharp; mandibles very small. Labium long and narrow.

Cephalothorax rather more than one-third of the total length; conical, flat, broad at the base. Lamellæ large, light-coloured, curved, rather fleshy-looking blades, set far apart, and usually nearly horizontal, but sometimes more on edge. Lamellæ widest posteriorly, where they terminate with a rounded shoulder just in front of the pseudo-stigmata; they diminish in width towards the anterior end, which is truncated. From the *lower* angle of the truncated edge springs an extremely thick, curved spine, the point of which almost touches the tip of the rostrum; from the upper angle springs *a thinner but longer spine, which runs parallel to the first.* It is difficult to say which of these two is the lamellar hair. Translamella a low, thick ridge. Pseudo-stigmata at the extreme edges and rear of the cephalothorax, very large, wide open, and facing *straight upward.* Pseudo-stigmatic organs almost globular, slightly pyriform, *actually sunk in the pseudo-stigmata.* Interlamellar hairs short, stiff spines, standing almost upright. Tectopedia extremely small; first hardly visible. Opisthophragmatic processes absent.

Legs stout, not long, fourth pair only just passing the hind margin. Femurs enlarged, otherwise of tolerably even thickness throughout, each joint except tarsi rough, and with one or more small steps, from each of which springs a hair. The tarsi have a bunch of rather thick hairs, and are short and blunt (fig. 7). The other joints have one or two short, curved hairs or spines on their outer or upper edges.

Abdomen oval, truncated anteriorly, the antero-lateral angles produced forward so as to form short points touching, and partly embracing, the pseudo-stigmata. Progaster sunk. There is a broad flattened margin all round the abdomen except the progaster; this margin is transversely striated, and bears a row of short, blunt spines. Inside this band the

notogaster is arched, and divided by ridges into irregular strips or bands, of which one or two run almost parallel to the progaster, and the others longitudinally. There are usually about ten of these bands in the width of the notogaster, they are often divided by cross ridges [they are rather too regular in the plate]. Each band contains two rows of round pits placed alternately, *i.e.* those in one row come between, and not opposite to, those in the adjoining row. Anal and genital plates very large, almost touching; they occupy the entire length of the abdomen. Ventral plate convex, rough, pitted all over.

Nymph.

Very similar to that of *Leiosoma palmicinctum* (which fact has induced me to place the species adjoining). They may easily be distinguished by the nervures in the scales being reticulated in *palmicinctum*, and irregularly branched in *ocellatus*.

Colour brown, form elliptical, dorsal surface almost covered by concentric rows of membranous scales, which extend far beyond the margin.

Cephalothorax broad, blunt, not hidden, the border of scales of the existing skin goes round the cephalothorax. Pseudo-stigmata dorsal, near together. Pseudo-stigmatic organs short, lancet-shaped.

Legs almost entirely hidden from the dorsal aspect, short, of about even thickness throughout. Tarsi very short.

Abdomen and cephalothorax form an ellipse together. Progaster almost straight, marked by a fold. The cast notogastral skins are carried concentrically, the larval (the central) skin is much raised, and bears three pairs of elegant, leaf-like, membranous scales. Each skin has about sixteen apophyses round its edge; there are four on the existing skin of the cephalothorax which complete the outer ellipse. Each apophysis bears a large, Japanese-fan-shaped scale, with a central ner-

vure ramifying by opposite branches, which divide dichotomously toward their ends, but the branching is not regular. The scales overlap and form a close border round the creature. There is one scale on each front leg—this in *L. palmicinctum* only occurs in the larva. There is not any sign of the four long hairs which are so conspicuous in *palmicinctum*, nor do the scales of the present species show iridescent colours. The nymph is usually so covered with dirt that it is difficult to distinguish the separate scales plainly. I have not coloured the figure, thinking the venation of the scales more distinct in monocrome.

Distribution.—I have found the species only at the Land's End, Cornwall, on lichens (chiefly *Fissia*); it is rare, and has not to my knowledge been recorded elsewhere.

CEPHEUS BIFIDATUS, *Nic.* Pl. XVI, fig. 8.

Cepheus bifidatus, Nic., p. 446.

Average length about ·8 mm.

Average breadth about ·6 mm.

Average length of legs (first and third pairs) about ·45 mm.

Average length of legs (second pair) about ·4 mm.

Average length of legs (fourth pair) about ·6 mm.

Colour extremely dark-brown or black, legs lighter brown.

Texture dull, rough, finely reticulated all over. General form very broad and round.

Rostrum rather sharp, slightly rounded at the tip.

Cephalothorax broad and conical. Lamellæ very wide, undulated, reticulated blades, set at an angle of about 45°. They have a large posterior lobe, which curves sharply down to the notogaster, and is broadest about a third of their length from the progaster; after this lobe there is a concave portion, and then the cusps

turn upward. Cusps of moderate length, very broad, truncated. Outer angle of truncated edge produced to a short, sharp point. Lamellar hairs long, setiform, springing from the middle of the truncated edge. Translamella not very marked. *Lamellæ separated anteriorly by a considerable distance or deep cleft.* Pseudo-stigmata large, placed at the very edge of the cephalothorax, directed forward and outward, not showing their openings from above. Pseudo-stigmatic organs long, curved, *almost filiform* [they are hardly long and thin enough in the plate]. Interlamellar hairs very long and setiform. Tectopedia large and reticulated.

Legs rather long; hind genuals very short, front ones longer. *Claws very heterodactyle.* Hairs fine, chiefly arranged in whorls.

Abdomen broad, rough, rounded posteriorly, truncated anteriorly. The antero-lateral angles are produced and form large, rough, irregular-shaped projections, adjoining the pseudo-stigmata; rough, flattened, chitinous bands run from these nearly half way along the edge of the abdomen, making it look bag-shaped instead of circular. Whole margin rough and nodose. Notogaster arched, bearing four rows of long, thick, setiform hairs; two pairs of similar smaller hairs on the hind margin. Genital plates much smaller than the anal.

I do not know the immature stages.

Distribution.—I only know this species from four specimens; one was sent me by Mr. George, of Kirton-Lindsey, and was somewhat injured; one by Mr. Bostock, of Stone; one by Mr. P. Cameron, of Glasgow, who found it near that city; the other I found dead and broken in Epping Forest.

The species has been recorded in France. Nicolet says that it is rare there; his figure gives a slightly different arrangement of the hairs on the notogaster, and the cleft between the cusps of the lamellæ is narrower

in his figure than in the English specimens which I have seen, but I think the species is identical.

CEPHEUS TEGEOCRANUS (*Herm.*). Pl. XVI, fig. 9; Pl. XVII, figs. 1—11; Pl. XXIV, fig. 10; Pl. C, figs. 12, 16; Pl. F, fig. 3; Pl. G, fig. 2.

Type species.

Notaspis tegeocranus,	Herm., 93, pl. 4, figs. 3, 4.
— —	Gervais. In Walck, vol. iii, p. 258.
Cepheus vulgaris,	Nic., 445, pl. 7, fig. 8.
— *tegeocranus*,	Can. e Fan., p. 10.
— —	Berlese, Acarofauna Sicula, p. 9.

Average length about ·90 mm.
Average breadth about ·55 mm.
Average length of legs (first pair) about ·55 mm.
Average length of legs (second pair) about ·50 mm.
Average length of legs (third pair) about ·52 mm.
Average length of legs (fourth pair) about ·80 mm.

A large, rough, dull species.

Colour varies much, from light yellow-brown to almost black. Legs lighter than the body. Lamellæ always very pale yellowish-buff.

Texture coarsely reticulated, both on upper and under surface. It has the appearance of being dotted, but when examined with sufficient care it is found to be reticulated (Pl. C, fig. 12).

Rostrum very blunt and wide. Rostral hairs on anterior edge. **Cephalothorax** broad and large. Dorso-vertex narrow, quite conical. Lamellæ very wide, sweeping blades, *turning inward and meeting anteriorly*, or leaving only a very narrow line between them, but turned outward toward the pseudo-stigmata: inner anterior angles produced to a point. Lamellar hairs inserted near outer angles, long, rough, rod-like. There is not any true space for a trans-

lamella. Pseudo-stigmata lateral, projecting, pointing outward and forward. *Pseudo-stigmatic organs long, almost straight*, clavate. *Interlamellar hairs large and rod-like.* Tectopedia *very* large, plainly seen from the dorsal aspect. Lateral opisthophragmatic processes large, turned inward; central processes absent. Apodemata joined to sternum.

Legs long, thin; hind genuals very short, front ones longer; hind tibiæ very long and thin; hairs fine, chiefly arranged in whorls. Claws almost homodactyle.

Abdomen broad, bag-like in form, rounded posteriorly, truncated anteriorly. Progaster slightly concave; whole margin somewhat rough and irregular; notogaster arched, with four rows of short, spine-like hairs, a smaller row round the hind margin, and a pair still smaller on the margin behind each pseudo-stigma. Genital and anal plates almost square, widely separated; the former small, the latter large.

Nymph.

Colour and Form.—External parts almost colourless, except rostrum and legs which are pinkish-brown. Whole creature, from the tip of the rostrum to hind margin of abdomen, about twice as long as its greatest breadth. From the dorsal aspect it appears divided into three well-marked divisions, viz. rostrum, cephalothorax, and abdomen. Whole surface highly polished, quite transparent; it presents a glassy appearance and shows all the internal organs through with remarkable distinctness. Thus, though the exo-skeleton is nearly colourless, the effect of colour is varied and harmonious.

The **Rostrum** is small, triangular, sharply divided from the remainder of the cephalothorax; distal parts of mandibles and maxillæ almost black, both show very plainly. Palpi conspicuous, standing free at the side of the rostrum, and passing its point; they are brown,

with three or four short, closely-set hairs at the tip, and a much stouter hair or spine on the outside of each joint. Proximal parts of the mandibles (within the camerastomum) brown, not so dark as the chelate portions; they are clearly seen through the dorsal surface, and, like the other trophi and the rostrum itself, are singularly mobile for one of the *Oribatidæ*. The mandibles are capable of being separately or jointly protruded to such an extent that their proximal bulbous part sometimes appears to alter the whole shape of the anterior portion of the animal, which depends very much on the extent to which the mandibles are extruded. The front legs are often employed in cleaning the trophi, as may be observed in *Gamasidæ* and some other *Acarina*.

The **cephalothorax** widens suddenly behind the rostrum, then continues almost cylindrical until it joins the abdomen; it is capable of considerable lateral motion and its colour is light yellow-brown. The pseudo-stigmata have a dark, chitinous ring round them. Pseudo-stigmatic organs short, clavate, and curving outward and backward. Inter-stigmatic hairs very long and flexible; there is a similar pair a little in front of them.

Legs do not reach the hind margin; they are densely clothed with long, fine hairs.

Abdomen oval, almost pointed posteriorly. Progaster almost straight. There are generally two or three sharply marked, irregular depressions on the notogaster, as if the surface were bulged in. Whole notogaster marked with extremely fine lines looking like scratches. About twelve very long, flexible hairs round the margin, and two pairs on the notogaster.

Distribution.—The nymph burrows in moss and old wood, but never has any dirt adhering to it.

The species is common and generally distributed. It has been recorded in Germany, France, Belgium, Switzerland, and Italy.

Cepheus latus, *Nic.* Pl. XVII, fig. 12.

Cepheus latus, Nic., p. 446.
— — Can. e Fan., p. 19.

Average length about 1 mm.
Average breadth about ·70 mm.
Average length of legs (first and second pairs) about ·4 mm.
Average length of legs (fourth pair) about ·55 mm.

A large, rough, dull species.

Colour.—Walnut-brown, not excessively dark, legs rather lighter. Lamellæ very pale yellowish-buff. **Texture** coarsely reticulated on dorsal and ventral surface; this effect is produced by closely set, deep pits.

Rostrum very blunt and wide, rostral hairs on anterior edge. **Cephalothorax.**—Dorso-vertex rather wide, almost conical, with a slight median carination. Lamellæ very wide, almost horizontal; they *approach so closely at their anterior ends* that they almost, or quite, touch; and any opening that exists is often filled with dirt. They are rounded anteriorly, and not produced to any point, as in *C. tegeocranus*. Lamellar hairs, inserted at outer anterior angle; long, thick, curved, and rough. There is not any space for a translamella. In spite of their size and horizontal position the lamellæ do not quite reach the lateral margin of the cephalothorax. Pseudo-stigmata lateral, projecting, pointing outward and forward. Pseudo-stigmatic organs *short, pyriform, recurved. Interlamellar hairs absent* (or extremely minute). Tectopedia *very* large, plainly seen from the dorsal aspect. Lateral opisthophragmatic processes large and rounded; median ones absent. Apodemata joined to the sternum.

Legs rather shorter than those of *C. tegeocranus*, but thicker; hind genuals very short, front ones longer. Third and fourth tibiæ very long. All legs have tactile hairs; other hairs arranged in whorls, mostly fine, but

a thick, imbricated hair on the outside of each of the three central joints of the two front pairs of legs. Claws almost homodactyle.

Abdomen broad, bag-like in form, rounded posteriorly, truncated anteriorly. Progaster slightly concave. Whole margin rough and irregular. Notogaster arched, with four rows of very fine, short, spine-like hairs. Nicolet does not give these, but they are present in the English specimens; a row of smaller hairs round the hind margin. Genital and anal plates almost square, projecting, widely separated; the former small, the latter large.

Distribution.—I have captured this species at Epping Forest, but have only found three specimens, the first was mounted for the microscope during the earlier part of my collecting. The drawing is one of the very few which have been made from a mount and not from the living specimen, for this reason the texture is too much like *C. tegeocranus*, it should be more plainly pitted. I subsequently found two other specimens, which enabled me to take this description from the life. Probably it escapes detection from its similarity to *C. tegeocranus*.

I am not acquainted with the immature stages.

It has been recorded in France and Italy.

Genus—SCUTOVERTEX,* *Michael*.

Apterogasterinæ, with cephalothorax anchylosed to abdomen; with lamellæ; the last three pairs of legs articulated somewhat under the body; tridactyle claws; chelate mandibles. The cephalothorax and abdomen joined by a central projection of the progaster.

There are only two British species of this genus with which I am acquainted, and I am not aware of any foreign records.

Both known species are rough and black. The sculpturings are not mere irregularities, but are

* *Scutum*, a shield; *vertex*, the top of the head.

arranged in a more or less definite pattern, tending to a large, oval centre of one design, with a broad border of a different ornamentation. The shape is an elongated ellipse, the notogaster not much arched.

The **Progaster** is greatly prolonged forward, with a convex outline, but toward the central part there fails to be any very distinct demarcation between it and the dorso-vertex, the former not standing free above the latter, as is usual in other genera where it advances at all, but being anchylosed to it; and the progaster has a long central point or other special form of projection, so that it is not easy to say which line should be taken for the end of one and the commencement of the other.

The **Rostrum** is not so blunt as in *Cepheus* and the whole cephalothorax is shorter and smaller.

The **Labium** is short, hardly covering half the camerastomum; it has a straight or slightly curved distal margin (Pl. XXIV, fig. 11). It is usually sculptured.

The **Palpi** are of moderate length, not usually visible from the dorsal aspect. The second joint is, as usual, the longest, and is also the thickest, but not greatly incrassated. The fourth has also a tendency to be thickened in one direction, particularly towards the distal extremity; the fifth is conical.

The **Maxillæ** are long and a good deal exposed, the two together presenting a triangular shape when *in situ*. They are bilobed, the inner lobe composed of two small teeth.

The **Mandibles** do not call for much special remark, they are of about the usual form and construction; they are quadri-dentate. The outer angle of the proximal end of the first joint is produced considerably more than the corresponding inner angle, giving the appearance shown at Pl. XVIII, figs. 3, 11.

The **Lingua** is small and conical, often difficult to see.

The usual **Interlamellar hairs** are absent.

The **Lamellæ** are clearly marked and may be blades nearly on edge, or mere thickened ridges; in either case they are nearly as far apart anteriorly as pos-

teriorly, thus bordering a more or less oblong dorsovertex, which is usually sculptured. The translamella is distinct. The pseudo-stigmata are dorsal and near together.

The **Tectopedia** diminish in size in this genus, they are sometimes scarcely marked, or they may form shallow recesses (*sculptus*), but far shorter and smaller than those of *Cepheus*, &c. On the other hand, a kind of chitinous shelf projecting from the lateral portion of the cephalothorax to support the articulations of the legs becomes of considerable size in this genus; and a large, chitinous apophysis, with an enlarged, bifid head, makes its appearance between the second and third pairs of legs; this apophysis will be found carried to an even greater extent in some subsequent genera, as *Damæus*.

The **Legs** are rather short and thick. The coxæ and femurs enlarged, but not flattened; these joints are usually sculptured, the other joints are often so to a lesser extent. The hind femurs generally have blades. The tibiæ and tarsi are often somewhat widened distally; the tibiæ of the first pair have the tactile hair carried on a chitinous projection or elevation in the central line (Pl. XVIII, fig. 6); this will be found again in *Eremæus*. The claws are tridactyle and very heterodactyle (Pl. XVIII, fig. 16). The legs are set more towards the edge of the body than in *Leiosoma* and *Cepheus*, thus approaching nearer to *Notaspis*.

The **Apodemata.**—The first and second are joined to the sternum, the third are not.

The **Genital Plates** are large and square; the anal plates large and pentagonal; the two pairs of plates approach near each other.

The **Tracheal system** is fully developed; the **Cæca** of the ventriculus medium-sized and almost globular; the **Ovipositor** rather short.

The nymphs are brown, leathery, much-corrugated creatures, very different from the imagos.

The adults are chiefly found in short ground-moss and lichen, also under stones, &c.

The genus is probably most nearly allied to *Eremæus*, to which genus it might be approached were these two the only genera to be considered, but it has many points of resemblance to *Cepheus* and other genera.

Table for identifying British species of Scutovertex.

Lamellæ blade-like; pseudo-stigmatic organs long; a space of transparent, smooth chitin on abdomen, near progaster; pits in centre of abdomen much larger than peripheral markings	*Sculptus.*
Lamellæ mere thickened bars; pseudo-stigmatic organs short; no smooth space; markings of notogaster about the same size all over	*Maculatus.*

SCUTOVERTEX SCULPTUS,* *Michael*. Pl. XVIII, figs. 1—8; Pl. XXIV, fig. 11.

Type species.

Scutovertex sculptus, Michael. Journ. R. Microsc. Soc., vol. ii, p. 242.

Average length about ·60 mm.

Average breadth about ·35 mm.

Average length of legs (first and third pairs) about ·35 mm.

Average length of legs (second pair) about ·30 mm.

Average length of legs (fourth pair) about ·40 mm.

An elaborately marked and handsome species.

Colour varies from dark red-brown to black, oftenest the latter; legs a little lighter. One smooth place on the notogaster quite light.

Texture, except the last-named smooth place, very rough, and without any gloss. General **form** a long oval.

Rostrum blunt, rather trilobed; in many positions a thin edge to the side lobes diminishes this effect. Rostral hairs short, curved inward. **Cephalothorax** small and narrow; all parts of its surface dotted with

* *Sculptus*, carved.

strong, evenly scattered, chitinous dots. Dorso-vertex almost square, slightly longer than broad. Lamellæ *reticulated blades on edge*, widest anteriorly. Cusps long, blunt, curved. Lamellar hairs terminal, thick, curved inward. Translamella a thickened bar. Provertex very distinct. The rostrum in front of it seems covered by a round plate, highest in the centre and at the edges. Pseudo-stigmata large, set far back. Pseudo-stigmatic organs rather *long*, spatulate at the distal ends, where they have a number of tooth-like points round the edge, and are generally rough. No interlamellar hairs. Tectopedia clearly seen from dorsal aspect, but rather small. A large apophysis, with a bifid head between the second and third pairs of legs. Opisthophragmatic processes very small and weak. Apodemata joined to the sternum.

Legs with femurs enlarged, hind ones with blades; first pair with thin proximal ends passing through clefts in the sternal shelf: tarsi very short. Tactile hairs of first pair of legs set on strong apophyses of the tibiæ (fig. 6) as in *Eremæus*. All the joints except the tarsi rather flattened, and rough with sinuous ridges. One or two thick, shortish hairs on each of the first four joints of each leg and numerous hairs on the tarsi.

Abdomen oval, produced anteriorly into a *long thin point, which passes over and is anchylosed to the dorso-vertex* [this is frequently narrower than that in the figure]. The whole edge of the notogaster is rough and irregular. The posterior margin has a central lobe with a sharp indentation on each side. The progaster is not straight nor curved, but runs at an angle of about 45° from each side to the base of the projecting point above named, so that it encloses a large triangular space, occupied as follows, viz. behind the projecting point is a short, thick, chitinous, transverse bar, which forms the anterior border of a *bag-shaped space of smooth, almost colourless chitin*, which, when the notogaster has been dissected off, is seen to be very thin,

almost a membrane, and has a raised margin round it. On each side of the last-named space is a small, triangular area, covered with raised dots like those on the cephalothorax; this is also bordered by a ridge, and outside this again is a much larger, long, irregular-shaped space bordered by another ridge composed of parts of the progaster and of the lateral edge of the notogaster.

Abdomen thick, notogaster arched but not strongly so, its *central part covered with large, irregular pits,* leaving broad, irregular, raised spaces or ridges between them. Peripheral parts thickly set with small raised dots. There are four short, spatulate hairs at the posterior margin, and two lines of four or five similar hairs on the notogaster near the edge [not well shown on the plate, and often difficult to see in life]

The whole sternal and ventral surface, including the labium and genital and anal plates, is rough with large raised spots. The genital and anal plates are large and near together, the former nearly square, the latter decidedly pentagonal.

The Nymph.

Colour light umber-brown, rostrum a little darker.

Texture dull.

Rostrum truncated, with a small blunt point. **Cephalothorax** conical, a full third of the entire length of the creature, very broad at base, being as wide as the progaster, which is nearly the widest part of the body. There are two square spaces in the central line, in front of one another; each surrounded by a ridge, and divided by a central longitudinal ridge. There are transverse markings between the ridges. Pseudo-stigmata dorsal, near together; pseudo-stigmatic organs long, lanceolate.

Legs set near the edge of the body; much like those of the adult, but shorter, and armed with a few stout spines in addition to the hairs.

Abdomen.—Progaster rather concave; abdomen narrows slightly towards the posterior margin, which is rounded, with a median indentation. Notogaster flat, deeply corrugated by irregular waved wrinkles of the cuticle, two or three of these run on to the corner of the cephalothorax, cutting off a small triangle on each side. Six or seven are parallel to the anterior margin, but get shorter as they recede from it. Behind these the folds enclose a trapeze-shaped space, then they tend to a reversed direction, but above the anus they point forward again; along the sides they are crowded and irregular, giving a broken outline. The wrinkles do not agree in different individuals, nor on both sides of the same one. The nymph is difficult to distinguish from that of *Oribata punctata*.

Distribution.—The species is found in moss; it is generally distributed and not uncommon in England, but I am not aware of its having been recorded elsewhere.

SCUTOVERTEX MACULATUS,* *Michael.* Pl. XVIII, figs. 9—16.

Scutovertex maculatus, Michael. Journ. R. Microsc. Soc., ser. ii, vol. ii, p. 13.

Average length about ·54 mm.

Average breadth about ·30 mm.

Average length of legs (first and fourth pairs) about ·33 mm.

Average length of legs (second and third pairs) about ·30 mm.

Colour, both of body and legs, very dark red-brown, almost black.

Texture dull, rough, thickly sprinkled with raised dots all over. General **Shape** an elongated ellipse, length nearly twice the breadth.

* *Maculatus,* spotted.

Rostrum small but rounded. Rostral hairs small and near together. **Cephalothorax** broad, rather large, but greatly covered by the progaster; it widens suddenly after the small part of the rostrum, and again after the insertion of the first pair of legs; the outline is rounded. Dots on the cephalothorax (except the dorso-vertex) irregular in shape and scattering. Dorso-vertex marked with raised wavy lines. Lamellæ *mere thickened bars*. Translamella the same, very well marked. No cusps. From about the middle of each lamella on the inside, another bar starts and runs backward at an angle, so that the two form a **V**-shaped ridge, the point of which is rounded and lies within a semi-circular indentation in the progaster. Pseudo-stigmata large and lateral; pseudo-stigmatic organs *very short*, with *heads broadly pyriform*, slightly indented at the top, but looking globular until dissected out; peduncles short, thick, and rod-like. Two pairs of short, thick hairs, representing the interlamellar hairs. Tectopedia very small, a strong chitinous projection between the second and third pairs of legs. Opisthophragmatic processes small and weak. Apodemata joined to the sternum.

Legs.—First three joints of each leg covered with raised dots; coxæ of first two pairs hidden beneath the body, those of the last two pairs rounded and conspicuous. Femurs of first two pairs with thin proximal ends turned almost at right angles where they are inserted into the coxæ, no blades; tarsi short, with a few fine hairs. Three short, thick hairs, on each tibia of the first two pairs; a few similar on the other joints, all caducous.

Abdomen elliptical, slightly pointed posteriorly, rather truncated anteriorly. It is indented on each side between the insertion of the third pair of legs and the pseudo-stigma. The progaster has a large indentation forming rather more than a semi-circle, this receives the point of the **V**-shaped ridge of the cephalothorax—at each side of this the progaster is so inti-

mately united to the dorso-vertex that it is difficult to say where cephalothorax ends and abdomen commences. Notogaster arched in the middle, arched part surrounded by a broad flattened band. It is entirely covered with closely set, raised, round or subquadrate dots, *of about even size all over*, those on the progaster transverse, those on the flattened band radiating, those on the arched portion irregular and labyrinthine in arrangement.

There are about ten short, thick, rather knobbed hairs, round the hind margin, very caducous. Genital plates almost square, set far forward; anal large, elliptical, touching the hind margin.

Nymph.

Colour dull, opaque-brown, often with a shade of dark olive-green. It is so broad and flat in general shape as to give the effect of having been flattened out, and it is covered with wrinkles and ridges all over.

Cephalothorax flat, long in proportion to the abdomen but not in proportion to its breadth, conical, sharply excavated at the edge for the insertion of the first pair of legs. Base of the cephalothorax narrower than the progaster; the second pair of legs are inserted in the angles thus formed. The cephalothorax bears a complicated series of ridges, not easy to describe, which will be best understood by reference to the plate. I will, however, endeavour to give an idea of their arrangement in words. The median (or axial) portion of the dorso-vertex is divided into three spaces, bordered by strong, raised ridges; the anterior is trapeze-shaped, with the small end foremost, and coming near to the point of the rostrum, but not reaching it; two short ridges, however, run from the anterior angles of the trapeze, one to each side of the rostrum very near to the point. The ridge

which forms the posterior border of the trapeze constitutes the anterior border of a hexagon, having curved unequal sides, convex inwards, the anterior being the longest, and the two next very short. The posterior ridge of the hexagon serves as the anterior margin of an ovate-oblong figure, sometimes slightly constricted in the middle; this figure extends back on to the abdomen. From the central angle on each side of the hexagon a short transverse ridge runs about half-way towards the lateral margin; from its termination a ridge runs forward to the front of the excavation for the first leg, and another, or continuation of the same, runs back to a circular ridge surrounding the pseudo-stigma, and from the pseudo-stigma a triangular space, bordered by another ridge, extends to the lateral margin. Pseudo-stigmatic organs short, with globular heads on short peduncles, very white. Interlamellar hairs absent or little seen.

Legs stout, gradually diminished toward the end; each of the femurs and tibiæ of the two front pairs bears a strong, serrated spine on the upper side; the other hairs on the legs are short; tactile hair absent.

Abdomen flat in general effect, but has somewhat raised anterior and lateral edges, and is raised to about the same extent along the median line, being slightly arched there; between this median portion and the lateral edge is a depressed channel. Whole abdomen covered with many closely-set, irregular wrinkles; three or four of these run along the anterior, and about half-way down the lateral, margin; the centre of the space enclosed by these last-named wrinkles is occupied by a set of folds bending strongly forward; behind them the wrinkles become more transverse, until near the posterior margin, where they again bend strongly forward. Posterior margin set with eight spatulate hairs, of which the two lateral pairs are very short; the two central pairs are much longer, and directed inward, which causes the central pair to cross.

Distribution.—I have found the species only on the lichen near the sea-shore at the Land's End, Cornwall; it has not to my knowledge been recorded elsewhere; it is not common.

Genus.—TEGEOCRANUS, *Nic.**

Equals part of *Cepheus*, Koch, and part of *Carabodes*, Koch.

Apterogasterinæ with cephalothorax anchylosed to abdomen; with lamellæ; the last three pairs of legs articulated under the body; monodactyle claws. Femurs of first two pairs of legs with slender peduncles and greatly enlarged heads (distal portions).

The members of this genus are always rough, and sculptured or spotted, they are usually black (*celatus* being an exception). The cephalothorax is generally large and broad. The abdomen mostly with a border of a different pattern (*velatus* and *labyrinthicus* being exceptions), and, as a rule, sharply truncated anteriorly.

The **Rostrum** is usually blunt and not carried so depressed as in most genera. The **cephalothorax** forms a larger proportion of the whole creature than in *Scutovertex*, &c. The progaster is nearly straight, the demarcation between abdomen and cephalothorax being remarkably clear (except in *celatus*), sometimes there is even a deep depression between the two (*coriaceus*, &c.). The progaster may be specially sculptured or may form a raised band.

The **Labium** is broad, often broader than long, it usually covers more than half the camerastomum; the form of its distal edge varies, it is sometimes convex, sometimes with a small median point, sometimes slightly concave, it is usually sculptured.

The **Palpi** are not often visible from the dorsal aspect, the second joint, although the longest, is not usually so much the longest as in many other genera; it is often considerably incrassated. The fifth joint

* Τέγος (τεγεος), a roof; κρανίον, the skull.

is long and generally slender, elliptical or inversely pyriform.

The **Maxillæ** are usually rather sharp, the denticulation varies, the inner lobe is sometimes square and simple, sometimes more cut into teeth.

The **Mandibles** are large and powerful, mostly tridentate, sometimes almost simple (*i.e.* without teeth).

The **Lingua** is not conspicuous.

The **Interlamellar** hairs are present in a few species only, when present they are thick or rod-like, not setiform.

The **Lamellæ** are well developed, but often in an exceptional manner; they may be large, undulating, and blade-like, resembling those of *Cepheus* (*T. latus*). They may be broad and substantial structures, almost horizontal, and not at all transparent, making the cephalothorax look very broad (*coriaceus*, &c.); this is the commonest form. They may be mere lines (*labyrinthicus*). They may be very powerful lateral thickenings of the cephalothorax (*femoralis*), in which case they lose their lamellar character. The translamella is seldom distinct.

The **Tectopedia** are usually well developed, and afford efficient protection to the front pairs of legs, which are also borne on a broad, chitinous shelf of the cephalothorax, as in *Scutovertex*, &c.; this, shelf is cleft by a narrow slit to admit the passage of the thin proximal ends of the femurs.

The **Opisthophragmatic processes** are entirely absent or very small, the median of these is not developed in any species which I know of.

The **Legs** in *Tegeocranus* are rather short, but very characteristic; indeed, the genus might be defined by them alone; they are articulated well under the body, the coxæ scarcely ever being visible from the dorsal aspect: the two front pairs of coxæ are small, the hind ones semi-globose or flattened. It is, however, in the femurs that the peculiarity of the leg occurs; those of the two front pairs, but especially the first, have small ball-and-socket articulations, then long,

slender, curved, rod-like peduncles, about half the length of the joint, and always smooth; these slip through the narrow slit in the chitinous shelf above named, having an up-and-down motion. Beyond this rod-like portion the joint suddenly enlarges to its greatest girth, which is considerable, it then diminishes again a little to its distal extremity, so that the whole joint is like a short mace (Pl. B, fig. 8); the enlarged portion is generally sculptured. The hind femurs are without the slender peduncles, but are broad and flattened, as in *Leiosoma*, &c., and are usually provided with blades. The tibiæ are, as a rule, long and considerably widened distally, often with an irregular outline. The tarsi vary a good deal, in typical species they are rather short, and are largest at the proximal end, diminishing regularly, but *latus* does not follow this rule. The claws are monodactyle, large, and strong (Pl. B, fig. 29).

The sternal and ventral plates are deeply excavated, in many species, for the reception of the legs, which can be folded almost wholly within the cavities (Pl. XXII, fig. 11).

The **Apodemata** approach close to, or join, the sternal region, but the sternum itself is occasionally very slightly marked, sometimes it cannot be traced, or only for a short distance.

The **genital** and **anal plates** are usually large, square, or pentagonal, and sculptured.

The **tracheal system** is developed: the **cæca** of the ventriculus are rather short, either rounded sacks or sometimes mere prolonged corners of the ventriculus, as in *Damæus*.

The creatures of this genus are usually found in dead wood and fungus, I think they chiefly subsist on fungi; they are sometimes found in moss, &c., but the other habitats are the principal.

Probably the nearest ally to this genus is *Cepheus*, but *Scutovertex* and others have also close analogies.

I know of seven British species.

Table for identifying the British species of Tegeocranus.

Form of abdomen broad; hairs bordering it short, fine, and radial; or absent.	Lamellæ, undulating blades, nearly on edge, or standing free.	Cephalothorax and abdomen sharply divided; markings on notogaster vermiform; margin of abdomen different; interlamellar hairs large and rod-like		*latus.*
		Cephalothorax and abdomen not clearly divided; markings on notogaster scattered dots; no different margin; no interlamellar hairs; outer layer of cuticle very loose		*velatus.*
	Lamellæ, thick horizontal plates, or triangular ridges; not standing free.	Markings on notogaster dots arranged in a winding and irregular manner.	Notogaster without any different margin	*labyrinthicus.*
			Notogaster with a margin different from the centre	*marginatus.*
		Markings on notogaster long rough bands.	Bands numerous and curved; four rows of spatulate hairs on notogaster; lamellæ thick horizontal plates	*coriaceus.*
			Bands few and broad, almost straight, with undulated sides; no hairs on notogaster; lamellæ massive triangular ridges	*femoralis.*
Form of abdomen very long; hairs bordering it thick and curved, lying *along* its edge				*elongatus.*

TEGEOCRANUS LATUS (*Koch*). Pl. XIX, figs. 1—9; Pl. B, fig. 17; Pl. D, fig. 5; Pl. E, fig. 15.

Tegeocranus cepheiformis, Nic. 465, pl. ix, fig. 1.
— — Haller.
Cepheus latus, Koch. Heft 3, fig. 11.

Average length about ·9 mm.
Average breadth about ·67 mm.
Average length of legs (first and second pairs) about ·45 mm.
Average length of legs (third pair) about ·4 mm.
Average length of legs (fourth pair) about ·5 mm.

Colour very dark, dull brown, without any gloss.
Texture rough; almost the whole dorsal surface cut into deep, vermiform corrugations. **Shape** broad and rounded.

Cephalothorax pyramidal or slightly pyriform. Rostrum small, rounded. Rostral hairs small and fine. *Lamellæ very large*, long blades on edge; near together anteriorly, with a sinuated upper edge; they are lighter in colour than the rest of the cephalothorax; they are clearly reticulated. Lamellar hairs fine, curved, placed at the upper anterior angles; cusps large and rounded. Translamella a short, thickened bar. Pseudo-stigmata large, open, slightly reniform, light in colour. Pseudo-stigmatic organs of moderate length, clavate, slightly recurved. Interlamellar hairs large, rod-like. Tectopedia large, clearly seen from dorsal aspect. Opisthophragmatic processes very fine. Sternum only slightly developed.

Legs long for the genus; femurs of the first pair have slender peduncles to suit the deep cleft in which they are inserted; the other femurs pyriform; genuals of two front pairs rather longer than usual; tibiæ slender and clavate. The first pair of legs only have the tactile hair. Tarsi are clothed with fine hairs, and there are a few fine, curved hairs, arranged in a

whorl, near the distal end of each of the other joints of each leg.

Abdomen *broad and rounded* in outline, little, if at all, longer than its width, it is truncated where it joins the cephalothorax, and is there broader than the latter, *from which it is plainly divided.* Notogaster distinctly divided into three regions, viz. a central and two borders, which borders, however, are absent from the progaster. The central portion is much arched, and *almost entirely covered by short, irregular, somewhat vermiform corrugations*, with sulcations between them; the surface of the corrugations is rough and granular. Immediately surrounding this central portion is a broad, granular band, sloping downward, which borders the hind and lateral margins as far as the space between the third and fourth legs on each side, where this border gradually becomes attenuated to a point, which does not stand free, but merely fades into the outer border. External to the last-named band is another zone, which surrounds the whole abdomen, except the progaster, and posteriorly is lower in level than the first-named border, but rises to the same plane anteriorly, and embraces the above-named points of the inner border. This outer border is very rough at the edge, and is marked with transverse striations or corrugations, giving a very broken outline. Anteriorly it forms the whole border of the abdomen, and there the striations are not so plain, but it projects as a rough prominence beyond the rest of the abdomen. There are not any hairs on the notogaster, and only a few extremely fine ones on the hind margin.

Genital and anal plates pentagonal, near together; whole ventral surface rough.

The **Larva.**—Colour brownish-white, texture semi-opaque, granular. General shape oval. Cephalothorax long, conical, rounded at the tip. Pseudostigmata dorsal; pseudo-stigmatic organs long, with filiform peduncles and lanceolate heads. Interlamellar

hairs strong, serrated, curved spines, set far forward; several transverse ridges on the rostrum. Abdomen, a rather long-shaped ellipse, notogaster arched, with a dark spot in the centre, margin rough, irregular, and bearing about twelve long, curved, strongly serrated spines; there are four pairs of similar spines on the notogaster.

Nymph.

This, with the single exception of *Leiosoma* (*Cepheus*) *palmicinctum*, is probably the most singular and elaborate creature among the British *Oribatidæ*. It will be best understood by the drawing, but I will try to describe it.

Colour light-brown or drab, legs and rostrum darker reddish-brown. Texture rough, granular, sometimes almost glittering. **Form** elliptical; the ellipse becomes broader at each change of skin; the edge is rough and broken by the granulations.

Rostrum blunt-pointed, cephalothorax small, conical. Pseudo-stigmata dorsal. Pseudo-stigmatic organs long, with filiform peduncles and lanceolate heads. Interstigmatic hairs strongly serrated spines set far forward.

Legs short, of about even thickness throughout, joints very rough and irregular in form. Each joint of the two front pairs of legs except the coxæ bears a whorl of long, curved, strongly serrated spines [these are not long enough in the plate]. There are a few similar ones, but shorter, on the outside of the hind pairs of legs.

Abdomen elliptical; notogaster flat; ventral surface arched, so that the notogaster stands much above the cephalothorax. The cast, notogastral, larval and nymphal skins are carried flat on the back, where the larval forms a central shield, and the nymphal concentric rings bordering it. The larval skin is as above described, but the edges turn in to cling to the notogaster, thereby forming a marginal fold. Round the margin of each nymphal skin are

about twenty large, flat, chitinous, brown, trifid or quadrifid projections (see Pl. XIX, fig. 2), of which three pairs are on the progaster; the central lobe of each projection carries an extremely long, doubly curved, very strongly serrated spine of clear chitin, which looks as though it were inserted like a bird's quill. These spines and projections, occurring on each skin, give the creature an appearance of extreme complication, and make it look like a *cheval-de-frise*. The projections vary considerably in size and shape, but preserve the same general character, the pair next to the central pair on the progaster is much the smallest, and the spines proceeding from it are simply curved inward, instead of being undulated; those proceeding from the central pair are almost straight and directed forward. The ventral surface is rough and lined, the genital and anal plates almost touch.

Distribution.—Species generally distributed, not uncommon; found in decayed stumps of trees, and fallen branches, in thick woods, &c. The nymph generally between the wood and the moss which grows on it.

The adult has been recorded in France and Germany.

TEGEOCRANUS VELATUS,* *Michael.* Pl. XXI, figs. 9—15.

Tegeocranus velatus, Michael. Journ. R. Microsc. Soc., vol. iii, pl. vi, p. 189.

Average length about ·32 mm.

Average breadth about ·17 mm.

Average length of legs (first three pairs) about ·12 mm.

Average length of legs (fourth pair) about ·14 mm.

A very small species, remarkable for the extreme facility with which the epiostracum becomes detached from the rest of the cuticle. It is not a typical *Tegeocranus* but still is, I think, properly placed in this genus.

* *Velatus*, clothed (as with a skin or veil).

Colour dull brown, not very dark.

Texture roughened by large, irregular, raised dots, which are upon an external membrane or skin (the epiostracum) which looks loose and is easily detached, so that it is rare to find a specimen which has not got more or less of it rubbed off, although I never saw one where it was entirely gone. The parts whence the epiostracum is gone are highly polished and light yellow-brown. The epiostracum appears almost as though it were the nymphal skin persisting, but this is not the case, the nymph is quite different.

Rostrum blunt, with an inclination to be trifid.

Cephalothorax very long. *Lamellæ large detached blades*, lying nearly horizontal, but not quite so; they extend beyond the lateral margin of the cephalothorax, and are curved and covered with raised dots. Cusps very large, almost reaching the tip of the rostrum. Lamellar hairs terminal, curved inward; translamella very distinct, but still a mere line. Pseudo-stigmata lateral, hidden by the projecting corners of the abdomen. Pseudo-stigmatic organs rather long, with slender peduncles, and broadly spatulate, almost disk-like, heads, covered with rough, raised points. *No interlamellar hairs.* Opisthophragmatic processes very small. Apodemata joined to sternum.

Legs short, not half the length of body; fourth pair do not reach the hind margin. Coxæ and femurs broad and flat, especially fourth pair. Peduncles of first femurs not so long or thin as usual in the genus. Each joint with one or more whorls of fine curved hairs. Femurs spotted.

Abdomen not clearly divided from cephalothorax, both on the same level. Outer skin (epiostracum) *very loose*, generally showing irregular depressions, as if pushed in, rough with raised dots, which cause an irregular outline. Notogaster not much arched, *no border to it*, posterior end rounded, anterior with the antero-lateral angles produced so as to form large, chitinous, flat, shelf-like projections, which seem almost

like rudiments of pteromorphæ, and cause the progaster to be the widest part of the creature. About six very short, fine hairs round the hind margin. Genital plates nearly square, anterior edge curved, anal plates much larger, almost triangular, posterior edge curved.

Nymph.

A beautiful object when seen alive by a sufficient amplification.

Colour pale grey.

Texture slightly granular. The abdomen appears at first sight to occupy nearly four-fifths of the entire length, closer inspection shows that the hinder part of the cephalothorax is included in this.

Rostrum blunt; anterior half of **Cephalothorax** narrow, almost parallel-sided; it bears a ridge along each side, two lesser ridges nearer to the median line, and some transverse wrinkles on the dorso-vertex. Pseudo-stigmata large and open, not raised. Pseudo-stigmatic organs long, gradually thickened toward the anterior ends, which are rounded and rough.

Legs short, of almost equal thickness throughout. Tibiæ of first pair overhanging the tarsi, as in *Eremæus*. Femurs the longest joints. Each joint with a whorl of fine hairs.

Abdomen almost coalesces with hinder part of cephalothorax, the two form an ellipse with major axis nearly twice the minor. Along the median line runs a raised band, which widens near the anterior and posterior margins; and it is there crossed by the transverse bands; these are usually four in number, each composed of three or four parallel wrinkles, they are doubly curved. The anterior curves forward and outward from the median line to the lateral margin. The others curve backward and outward.

Distribution.—The species is generally distributed but not very common. It lives in moss. I am not aware that it has been found out of England.

TEGEOCRANUS CORIACEUS (*Koch*). Pl. XX, figs. 1—8; Pl. XXII, fig. 11; Pl. XXIV, fig. 12; Pl. B, figs. 5, 8, 29; Pl. C, fig. 2.

Type species.

Carabodes coriaceus, Koch. Heft 3, pl. xv.
Tegeocranus — Michael. Journ. R. Microsc. Soc., vol. ii (1879), p. 248.

Average length about ·62 mm.
Average breadth about ·40 mm.
Average length of legs (first pair) about ·35 mm.
Average length of legs (second pair) about ·28 mm.
Average length of legs (third pair) about ·30 mm.
Average length of legs (fourth pair) about ·40 mm.

A strongly marked and sculptured species.
Colour black.
Texture rough, dull. Chitin thick and massive.
Rostrum blunt. **Cephalothorax** long, broad, almost as wide as progaster; flat, nearly triangular. Dorso-vertex rather lighter in colour, and bearing two small, raised, black ridges, almost joined, which curve backward from behind the middle of the lamellæ; and join a great, raised, chitinous, undulated, transverse ridge, very thick and rough, which is depressed, almost to the level of the dorso-vertex, in the middle, but swells into great rounded lobes immediately on each side of the depression, and then curves down to the pseudo-stigmata. Between this transverse projection and the progaster is a deep, irregular-shaped trench, which forms a conspicuous feature. *Lamellæ large, thick, horizontal* plates, very rough, and seeming to form part of the surface of the cephalothorax, although really only attached by their inner and terminal edges; they reach almost to the point of the rostrum. Lamellar hairs terminal, curved. No translamella. Pseudo-stigmata large, raised, lateral, pointing outward. Pseudo-stigmatic organs long, proximal parts nearly straight and

* *Coriaceus*, leathery.

upright, terminal portion gradually thickened, rough, curving forward. Interlamellar hairs thick, spatulate, light-coloured. Tectopedia large and strong, second pair very conspicuous. Apodemata joined to the sternum.

Legs rather short; femurs incrassated, rough; first pair (Pl. B, fig. 8) with very long, slender, smooth, peduncles passing through a narrow slit in the sternal shelf. Tarsi short. Genuals and tibiæ with whorls of fine hairs.

Abdomen nearly as broad as long. Progaster with a rounded central projection, *thence* concave on each side. Lateral and posterior margins of abdomen bordered by a broad, flat, double (in thickness) band with a very irregular edge, and marked by radiating ridges. Notogaster within this margin arched and divided into numerous rough curved bands, marked like Morocco leather (whence doubtless the name). Four rows of rather spatulate, white hairs on the notogaster, and some very fine and short hairs round the hind margin. Sternal plate excavated to receive the legs when folded. Genital and anal plates almost square, the latter much the larger.

Nymph.

A fat-looking creature, a good deal like a *Tyroglyphus* (cheese-mite).

Colour semi-transparent white, rostrum and legs pink. Texture polished, no markings anywhere; whole creature thick (from dorsal to ventral plates), too much so to stand long upright on a level surface. Two rows of long, flexible hairs along notogaster and cephalothorax; genital and anal plates projecting and haired. Notogaster very arched.

Distribution.—The species lives chiefly in fungus and old wood, the nymph burrows into the substance; it is generally distributed and common. It has been recorded only in Germany (by Koch) to my knowledge.

TEGEOCRANUS FEMORALIS, *Nic.** Pl. XX, fig. 9.

Tegeocranus femoralis, Nic. P. 466 (pl. ix, fig. 2).

Average length about ·62 mm.
Average breadth about ·36 mm.
Average length of legs (first and fourth pairs) about ·30 mm.
Average length of legs (second and third pairs) about ·25 mm.

This species has a great general resemblance to *T. coriaceus*, but is distinct from it, and not to be mistaken after careful examination.

Colour black. **Texture** rough, dull. Chitin thick and massive.

Rostrum blunt. **Cephalothorax** rather long, considerably less broad than the progaster, flat, trapeze-shaped. Dorso-vertex with a decided central, longitudinal ridge or elevation. There is a great, chitinous, curved, transverse ridge, very thick and rough, behind the dorso-vertex, not quite as projecting as the similar formation in *coriaceus;* it has a deep depression or trench behind it, but not quite so large nor profound as in the last-named species; there is also a narrow ridge behind this, forming the hind margin of the cephalothorax. Lamellæ *very thick, horizontal plates or ridges, raised in the median line so as to be triangular in cross section*, very massive, seeming to form part of the surface of the cephalothorax, and although really only attached by their inner edges, reaching almost to the point of the rostrum. No lamellar nor interlamellar hairs, nor translamella. Pseudo-stigmata large, raised, lateral, pointing outward. *Pseudo-stigmatic organs long, almost filiform.* Tectopedia large, second pair very conspicuous. Apodemata joined to the sternum.

Legs short, femurs incrassated, rough, first pair

* Femur, the thigh.

with long, slender, smooth peduncles. Genuals and tibiæ with whorls of fine hairs.

Abdomen decidedly longer than broad, rounded posteriorly, almost parallel-sided; progaster almost straight, and forming a rough ridge. Lateral and posterior margins bordered by a broad, flat band, with a very irregular edge, and marked with radiating ridges. The anterior ends of this band are greatly enlarged, so that the abdomen is widest immediately behind the progaster. Notogaster within this margin somewhat arched, and divided into about five or six *longitudinal, irregular bands*, which are rough and granular. *No hairs on the notogaster.* Sternal plate excavated to receive the legs when folded. Genital and anal plates almost square.

I am not acquainted with the immature stages of this species.

Distribution.—I have only found three or four specimens of this species in Epping Forest, but I have seen three found near Glasgow by Mr. Cameron; Nicolet found two or three in the woods of Satory; it has not, I believe, been recorded elsewhere.

TEGEOCRANUS LABYRINTHICUS, *Michael*. Pl. XXI, figs. 1—4, 6—8; Pl. XXII, fig. 3.

Tegeocranus labyrinthicus, Michael. Journ. R. Microsc. Soc., vol. ii (1879), pl. xi, p. 249.

Average length about ·45 mm.

Average breadth about ·25 mm.

Average length of legs (first and third pairs) about ·22 mm.

Average length of legs (second pair) about ·18 mm.

Average length of legs (fourth pair) about ·25 mm.

Colour deep red-brown. It is some time after the adult emerges before it acquires the dark colour; soon after emerging it is much lighter.

Texture rough and dull.

Rostrum very blunt. **Cephalothorax** large and broad, joined to abdomen by its full width. Dorsovertex much arched; there is a sharp depression between it and the abdomen, caused by the curvature of these parts. Whole cephalothorax rather lower in level than abdomen. Rough with irregular raised markings and reticulations. When seen by transmitted light the hind part appears bulbous, and to end anteriorly in a long central ridge; this is not easily seen in living specimens. Lamellæ thick, narrow, horizontal, curved plates; these, in the living creature, are difficult to distinguish from the general surface of the cephalothorax, although showing plainly by transmitted light; they almost reach the tip of the rostrum. Lamellar hairs terminal, curved. No translamella nor interlamellar hairs. Pseudo-stigmata large, lateral, much raised, pointing outward. Pseudo-stigmatic organs recurved, with slender peduncles and pyriform heads slightly excavated at one side. [The figure of this is on Pl. XXII; that on Pl. XXI belongs to *T. marginatus*.] Tectopedia large, particularly second pair, which are very rough.

Legs rather short, fourth pair slightly pass the hind margin. First and second pairs carried on a chitinous shelf of the cephalothorax. Femurs of first pair with long, slender, smooth peduncles, passing through a cleft in the shelf; peduncles of second pair shorter and more curved, none to third or fourth pairs. Femurs (beyond the peduncles) much enlarged, rounded exteriorly, flat against the body (inner side); very rough. Coxæ also rough. Genuals very small. Tibiæ long, incrassated distally; first pair only with tactile hair. A thick hair on each genual of first pair, two or three smaller on femur. A few short, blunt, curved hairs on the other joints; tarsi with fine hairs.

Abdomen longer than broad, antero-lateral angles projecting, posterior margin rounded. Progaster truncated, slightly convex; notogaster much arched, covered with large raised dots, which sometimes coa-

lesce, and sometimes are perfectly distinct; the coalescence is best seen by transmitted light in mounted specimens after preparation. These dots are *never disposed in straight lines nor regular forms*, they chiefly present *a vermiform or mazy arrangement* (whence the name of the species), they show distinctly at the edge of the abdomen, making it irregular. *There is not any border to the notogaster;* it bears four rows of short, curved hairs. There is a row of straight hairs round the hind margin. The whole sternal surface and labium are reticulated, the ventral covered with dots, like the notogaster. Genital and anal plates square, the latter slightly the larger.

The Nymph.

Colour almost white, rostrum and legs often slightly brownish; there are sometimes two or three vague brownish patches on the notogaster.

Texture granular, semi-transparent, granulations often difficult to see. The general effect is of a fat little creature like an inflated bladder.

Cephalothorax with a depressed margin and an arched central elevation; rounded anteriorly, and having one or two obscure folds. Another small fold gives a truncated appearance at the base of the rostrum. Palpi plainly visible from dorsal aspect; pseudo-stigmatic organs long, filiform. Inter-lamellar hairs filiform, set far forward, not so long as the pseudo-stigmatic organs.

Legs short, thick, gradually diminishing toward their distal ends.

Abdomen slightly rounded anteriorly, obtusely pointed posteriorly. Progaster bordered by one or two folds of cuticle. Notogaster arched. Abdomen sometimes has a roughly triangular depression at each side commencing near the progaster and extending about half way back on dorsal surface, but coming to

a rounded point near the ventral. This depression is not bordered by angles, but looks like the sinking in of a viscid material. Four pairs of longish hairs round hind margin, two or three pairs on notogaster, and two pairs of much shorter curved hairs at the sides.

Distribution.—Species common and generally distributed; nymph chiefly found in moss on walls, and on lichen. I am not aware that it has been recorded out of England.

TEGEOCRANUS MARGINATUS, sp. nov. Pl. XXI, fig. 5; Pl. XXII, figs. 1, 2.

Average length about ·5 mm.
Average breadth ·28 mm.
Average length of legs (first and second pairs) about ·25 mm.
Average length of legs (fourth pair) about ·32 mm.

A species intermediate between *coriaceus* and *labyrinthicus*.

Colour deep red-brown.

Texture rough and dull.

Rostrum rounded. **Cephalothorax** large and broad; joined to abdomen by its full width, rather flat. There is a deep trench between it and the progaster, bordered anteriorly by two large, chitinous elevations, as in *coriaceus*. Whole dorsal surface of cephalothorax very rough. Lamellæ large, thick, horizontal, curved plates, strongly reticulated, and extending from the pseudo-stigmata to near the tip of the rostrum. Lamellar hairs very small, terminal. Translamella a mere line, but well marked. Pseudo-stigmata large, lateral, much raised, pointing outward. Pseudo-stigmatic organs strongly curved forward and upward, gradually increased in width until near the distal end, then becoming small again; *very rough with long spines on the outer side of the curve.* No interlamellar hairs. Tecto-

pedia large, particularly the second one. Apodemata joined to sternum.

Legs of moderate length. Fourth pair pass the hind margin substantially. First and second pairs carried on a chitinous shelf of the cephalothorax. Peduncles of first femurs long and smooth, not quite so long as in *labyrinthicus;* none to the other legs. Femurs enlarged, rounded exteriorly, flat interiorly; very rough. Tibiæ long, slender, incrassated distally. Tactile hairs on first pair of legs only, a few thickish hairs on most joints.

Abdomen longer than broad, rounded posteriorly, truncated anteriorly. Progaster slightly convex. Lateral and posterior margins of notogaster *bordered by a rough, flat band or margin,* with radiating ridges. Notogaster within the band much arched, covered with large, raised dots, close together but not usually coalescing, arranged in an irregular and labyrinthine manner. Four rows of short, thick hairs on notogaster, and a few radiating fine hairs round the hind margin. Whole sternal and ventral surface, including labium, very rough. Genital and anal plates square, the former almost as large as the latter.

Nymph.

A fat lump, a good deal like the nymph of *coriaceus.*

Colour semitransparent white; rostrum and legs pink. **Texture** polished.

Cephalothorax and **Abdomen**.—Pseudo-stigmata dorsal; pseudo-stigmatic organs rather long, pyriform. Legs short. Notogaster bears about seven pairs of long, fine hairs. The creature is almost too much rounded to stand upright on a flat surface.

Distribution.—The species is found in moss, and is not uncommon; I believe it has not hitherto been recorded.

TEGEOCRANUS ELONGATUS,* *Michael.* Pl. XXII, figs. 4—10.

Tegeocranus elongatus, Michael. Journ. R. Microsc. Soc., vol. ii, p. 250, pl. x.

Average length about ·68 mm.
Average breadth (greatest) about ·32 mm.
Average breadth at progaster ·20 mm.
Average length of legs (first and fourth pairs) about ·25 mm.
Average length of legs (second and third pairs) about ·20 mm.

A very exceptional species, chiefly from its form.
Colour black.
Texture rough, with deep pits, and dull. General **Shape** from rostrum to posterior margin very long, pyriform; the line of the cephalothorax being continuous with that of the abdomen.

Rostrum bluntly pointed. Rostral hairs conspicuous but short, very curved. **Cephalothorax** long, its base as broad as the notogaster. Dorso-vertex flat, coarsely-pitted, and often with a few ridges anteriorly. Lamellæ rather narrow, thick, reticulated plates, almost horizontal, projecting laterally beyond the rest of the cephalothorax, and plainly divided from the dorso-vertex; they nearly reach the tip of the rostrum. Lamellar hairs inserted somewhat behind the anterior end, large, thick, curving inward; they often cross above or beyond the rostrum. No translamella. Pseudo-stigmata lateral, projecting, pointing outward; pseudo-stigmatic organs long, recurved, gradually widened toward the distal ends, which are almost square, and have three or more short points, which are the terminations of long ridges on the surface of the widened part of the organ. Inter-lamellar hairs long, thick, curved, very close to the lamellæ.

* *Elongatus*, lengthened.

Tectopedia large, rough, first pair like duplicate lamellæ, but shorter, second very conspicuous. Apodemata joined to the sternum.

Legs short, the fourth pair not reaching the posterior margin. Femurs considerably enlarged, rough, rounded exteriorly, flattened interiorly, first pair with long, smooth, curved peduncles; fourth pair with blades. Tibiæ and tarsi thin, the latter short. There is a whorl of thick hairs on each genual, the outer hair being thickest; there is also a whorl on the first femur, and one very thick hair on the outside of each of the others. Hairs on tibiæ very fine, tactile hairs on front pair only.

Abdomen very coarsely pitted all over, pits rounded and irregular, no hexagonal forms. Widest part near posterior margin, which is rounded. Progaster truncated, almost straight. Lateral and posterior margins bordered by a very rough, striated band, not very wide, within this the notogaster is arched; it bears four rows of long, thick, rod-like, curved hairs. There is a row of similar hairs round the margin, rather smaller than those on the notogaster, very much *recurved, and arranged along the edge, not radiating*. Whole ventral surface coarsely and irregularly pitted; genital and anal plates square, widely separated, the latter much the larger.

Nymph.

Colour white or greenish-grey; rostrum and legs pinkish, pseudo-stigmata brown; internal organs show through very plainly. **Texture** glossy, highly polished, very transparent. **Shape** much that of perfect creature, sufficiently so to be easily recognised; on a closer examination considerable difference will be observed. The **Cephalothorax** is not quite so long in proportion to the abdomen as in the adult, and its sides are not quite so straight; the anterior half has

the straight-sided, conical form, curving bluntly toward the apex, but the basal half is enlarged on each side, so as to form a rounded lobe, the effect of which is to leave a sharply-marked lateral notch between cephalothorax and abdomen; this notch is immediately above the insertion of, and affords space for the upward motion of, the second pair of legs; the first pair is situated immediately in front of the rounded lobe, which is pierced by the pseudo-stigma a little outside its centre. Pseudo-stigmatic organs with somewhat thinner peduncles, and somewhat more suddenly thickened towards the distal ends, than in the adult. The interlamellar hairs point upward and outward. The lamellar hairs are found on the dorso-vertex in the nymph between the interlamellar and rostral hairs; they are only slightly curved, and point upward and forward. Palpi conspicuous; their distal joints densely clothed with hairs; the mandibles are also commonly seen projecting beyond the rostrum, and are very large.

Legs shorter than in the adult, the two hind pairs considerably so, the fourth pair not attaining the posterior margin by about one third of the length of the abdomen. The tibia of each of the two front pairs of legs is produced to a short point which overhangs the tarsus, and bears an extremely long tactile hair; tarsi of these legs thickly clothed with hairs, and short curved hairs are closely set along all the legs.

Abdomen slightly constricted above the insertion of the fourth pair of legs, and somewhat more pointed posteriorly than in the adult; it has an irregular depression exterior to the line of the alimentary canal, and bears a strong spine on each side at the antero-lateral angle, and about ten short ones round the hind margin. The notogaster is crossed by fine depressed lines.

Distribution.—The species lives in decayed wood,

and is very sluggish; the nymph burrows, and may be found by pulling the wood to pieces.

The species is generally distributed and not uncommon; I am not aware that it has been recorded out of England.

GLOSSARY,

Showing the sense in which the following words are used in this book.

ACARI.—The true *Acari, i.e.* the *Tyroglyphidæ, Sarcoptinæ,* and *Analginæ.*

ACARINA.—The whole order of Mites comprising: *Trombidiidæ, Cheyletidæ, Hydrachnidæ, Limnocaridæ, Gamasidæ, Oribatidæ, Ixodidæ, Myobiadæ, Acari, Arctisconidæ, Demodicidæ, Phytoptidæ,* &c.

ACETABULUM.—The basilar cavity, or inward, cup-like projection of the sternal exo-skeleton, into which the coxa of a leg is articulated.

ACROPLEURON (ἄκρος, at the summit; πλευρὸν, a side).—The portion of the exo-skeleton of the side of the cephalothorax lying below the lamella and above the first tectopedium.

ADULT.—The perfect creature after it has undergone its last ecdysis and has become sexually complete.

ANAL PLATES.—Two chitinous folding-doors forming part of the ventral exo-skeleton, and serving, when shut, to entirely close the opening by which the anus communicates with the exterior.

APODEMATA.—Chitinous ridges on the inner side of the sternal (or ventral) surface, running from the legs toward the centre of the body, and forming supports for the legs and giving points of attachment to muscles. They are (in the *Oribatidæ*) infoldings of the cuticle, primitively arising between two segments.

BASILAR CAVITY.—See acetabulum. Nicolet compre-

hends in this expression the whole space enclosed by the tectopedia.

BASIPLEURON (βάσις, a base; πλευρὸν, a side). The portion of the exo-skeleton of the side of the cephalothorax lying between the two tectopedia (or the places where they would be if they are not developed).

CÆCA.—Two paired diverticula of the hinder part of the ventriculus, often very large, and usually directed backward, which probably have chiefly a secretive office.

CAMERASTOMUM.—The cavity of the rostrum closed below, more or less, by the labium; and which contains the trophi, &c.

COLON.—That portion of the hind gut which lies between the small intestine and the rectum.

COMPLETE TRANSFORMATIONS.—A life-history wherein the immature forms differ from the adults, and which includes a special, inactive, pupal stage.

COXA.—The free joint of the leg which is moveably attached to the body, *i.e.* articulated in the acetabulum.

CUSPS OF THE LAMELLÆ.—The portions of the anterior ends of the lamellæ, which cease to be attached to the cephalothorax by their lower edges.

DEUTOVIUM STAGE.—The period in the development of the ovum, in some *Acarina*, when the original outer shell, or cuticle, having split, the inner lining-membrane becomes, either wholly or partly, the external shell.

DORSO-VERTEX.—That portion of the exo-skeleton of the upper portion of the cephalothorax which adjoins the abdomen, and is bounded laterally by the lamellæ, and anteriorly by the provertex, when these parts are present.

ECDYSIS.—A change of skin, either during growth or on the transformation from one stage to another.

ECTOSTRACUM.—The median layer of the cuticle, usually much the thickest.

Endostracum.—The inner layer of the cuticle.

Epideme.—A chitinous infolding or projection of the cuticle into the body, proceeding from one segment only, not between two.

Epimera.—Chitinous, rod-like or blade-like pieces sunk in the sternal cuticle of soft-skinned *Acarina*, and forming a rigid skeleton for the support of the legs.

Epiostracum.—The thin outer layer of the cuticle.

Expulsory vesicles.—Paired sacs found in some *Oribatidæ*, &c., chiefly in the abdomen, and containing an oily fluid, which they discharge to the exterior through a pore in the exo-skeleton.

Femur.—The second free joint of the leg, counting from the body.

Frons.—The portion of the superior exo-skeleton of the cephalothorax lying anterior to the provertex, and bordered laterally by the genæ.

Genæ.—The portions of the exo-skeleton forming the sides of the rostrum.

Genital plates.—Two chitinous folding-doors, forming part of the ventral exo-skeleton, and serving, when shut, to entirely close the opening through which the exterior genital organs are extruded.

Heterodactyle claws.—In the *Oribatidæ*, tridactyle claws, of which the central unguis is different from the lateral ones.

Hind gut.—In the *Oribatidæ*, the small intestine, the colon, and the rectum.

Homodactyle claws.—In the *Oribatidæ*, tridactyle claws, of which all three ungues are similar.

Imago.—See adult.

Incomplete transformations.—A life-history wherein the immature stages differ from the adult, but which does not include any special inactive pupal period.

Inert stage.—A period of absolute inactivity preceding each transformation and ecdysis, and during which the creature seems dead.

INTERLAMELLAR HAIRS.—Two strong hairs usually present, arising from the dorso-vertex between, but in front of, the pseudo-stigmata. They are the inter-stigmatic hairs, or hairs of the vertex with Nicolet.

JOINT.—When a limb, palpus, &c., is divided by articulations into more than one piece, "joint" means a piece between two articulations or beyond the last articulation; not the articulation itself.

LARVA.—In the *Oribatidæ* and most other *Acarina*, the young creature after it has emerged from the egg and while it is still hexapod.

LAMELLÆ.—Two chitinous, paired, longitudinal outfoldings of the cuticle of the cephalothorax, usually blade-like, bordering the sides of the dorso-vertex.

LAMELLAR HAIRS.—Two conspicuous hairs usually borne, one on each lamella, at or near the anterior end (by the cusps when present), and directed forward or upward.

MAXILLARY LIP.—A lip below the mouth, formed by the fusion of the whole, or the basal parts of the maxillæ, either with or without a true labium.

NOTOGASTER.—The dorsal surface of the abdomen.

NYMPH.—In the *Oribatidæ*, and most other *Acarina*, the young creature after it has become octopod and before the last ecdysis.

OPISTHOPHRAGMATIC PROCESSES.—Chitinous projections (usually two to four in number) springing from the posterior side of the phragma, and extending backward into the abdomen.

ORISMOLOGY.—The nomenclature of the different parts and terms applied thereto (terminology).

PARASTERNA.—The thin portions of the sternal plate lying between the true sternum and the apodemata.

PERIENCEPHALON.—A clear outer casing which envelops the great supra-œsophageal ganglion.

PREVENTRICULAR GLANDS.—Two paired glands, lying one on each side of the œsophagus just where it enters the ventriculus.

PHRAGMA.—The chitinous internal partition partially dividing the cephalothorax from the abdomen.

PROGASTER.—The anterior margin of the abdomen.

PROVERTEX.—A short portion of the dorsal surface of the cephalothorax lying between the frons and the dorso-vertex. It is not always developed.

PSEUDO-STIGMATA.—Two paired, chitinous, tubular, or funnel-shaped organs, found at the base of the cephalothorax in all *Oribatidæ*, usually near the lateral margin, and formerly supposed to be true stigmata.

PSEUDO-STIGMATIC ORGANS.—Two paired, fleshy, or setiform organs varying greatly in shape, &c., which proceed one from the interior of each pseudo-stigma, and probably are sense organs.

PTEROMORPHÆ.—Two paired, chitinous, more or less flexible, wing-like expansions, of the anterior part of the lateral margin of the notogaster.

RAPTORIAL PALPI.—Palpi with the distal joint articulated, usually near the base of the penultimate, so as to form seizing organs for predatory species.

ROSTRAL HAIRS.—Two paired hairs set near the tip of the rostrum, and usually present; sometimes there is a second pair farther back.

SCLERITE.—Any chitinous piece forming a rigid part, usually in a soft cuticle.

SECURIFORM.—Hatchet-shaped.

SUPER-COXAL GLANDS.—Saccular organs, usually doubled back and attached above the coxæ of the second pair of legs, possibly answering to the nephridia of Vermes.

TACTILE HAIR.—A long setiform hair arising from the upper and anterior surface of the distal end of the tibia, and forming an organ of touch. It is almost always present on the 1st pair of legs and sometimes on other pairs also.

TARSUS.—The distal joint of the leg—including the claw.

TECTOPEDIA.—Ridges formed by outfoldings of the chitinous cuticle, and which leave between them large cavities into which the front legs can be withdrawn or folded. There are usually two on each side.

TECTUM.—An organ supposed by Nicolet to exist, and to be a chitinous shelf, generally attached by its hind edge only, and overhanging the cephalothorax; it does not, however, really exist.

TIBIA.—The penultimate joint of the leg, *i.e.* the fourth free joint, counting from the body.

TRANSFORMATIONS.—See complete transformations, and incomplete transformations.

TRANSLAMELLA.—A chitinous ridge joining the lamellæ (at the commencement of the cusps, if any), and bordering the dorso-vertex anteriorly.

VENTRAL PLATE.—The chitinous shield covering the ventral surface of the abdomen, and pierced by the apertures which are closed by the genital and anal plates.

VAGINA.—The unpaired duct between the paired oviducts and the ovipositor.

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PELOPS ACROMIOS. (Page 208.)

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3. Under side of adult. × 80.

4. Mouth-organs of nymph, as seen from below, with the mandibles fully extended. × 180. (*a*) Epistome (edge of camerastomum); (*b*) rostral hairs; (*c*) mandibles; (*d*) maxillæ (seen nearly on edge); (*e*) palpi; (*f*) labium; (*g*) lingula.

5. Labial organs of adult, seen from above (within); × 100. (*e*) palpi; (*d*) maxillæ; (*f*) labium; (*g*) lingula.

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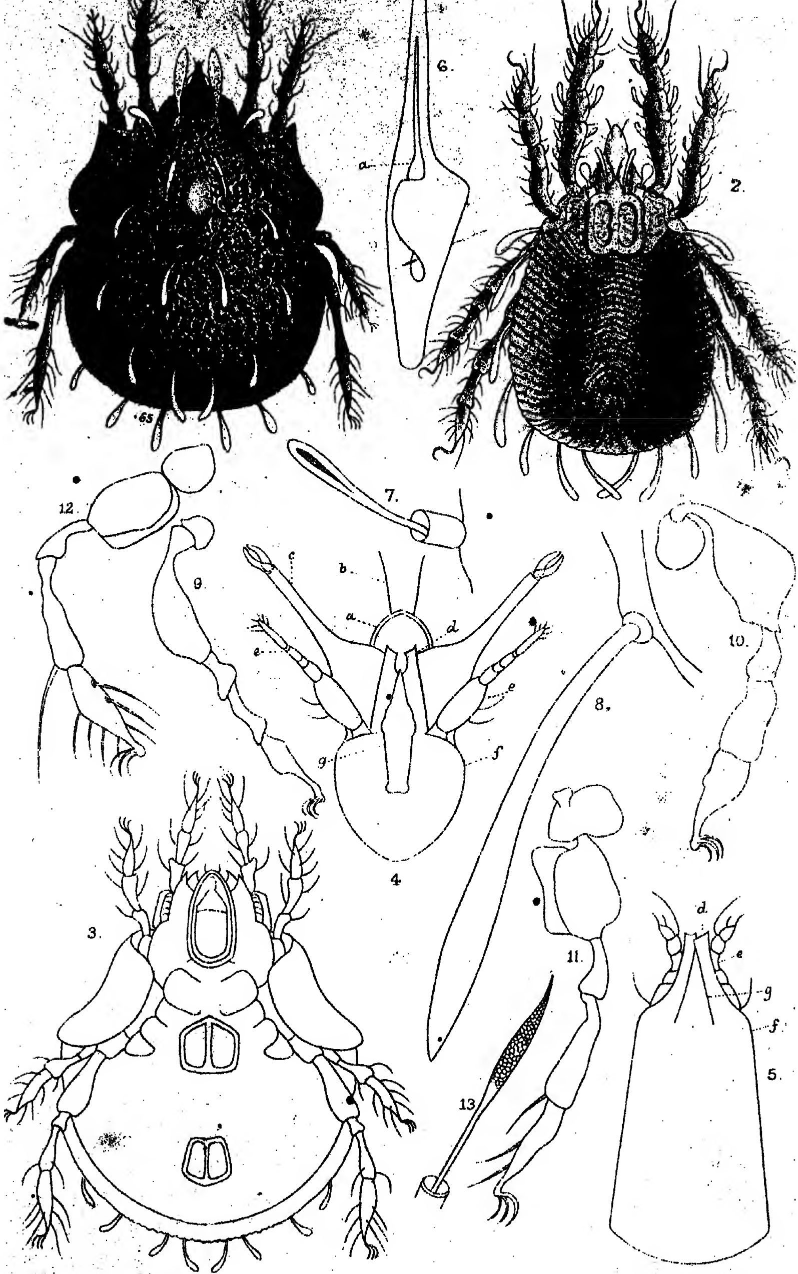
PELOPS FARINOSUS. (Page 212.)

13. Pseudo-stigma and pseudo-stigmatic organ; × 250.

N.B.—All amplifications and measurements are linear.

PLATE



A.D. Michael ad nat. del. W. Blain sc.

Mintern Bros imp.

Pelops acromios 1—12
——— farinosus 13

PLATE II.

Pelops lævigatus.* (Page 213.)

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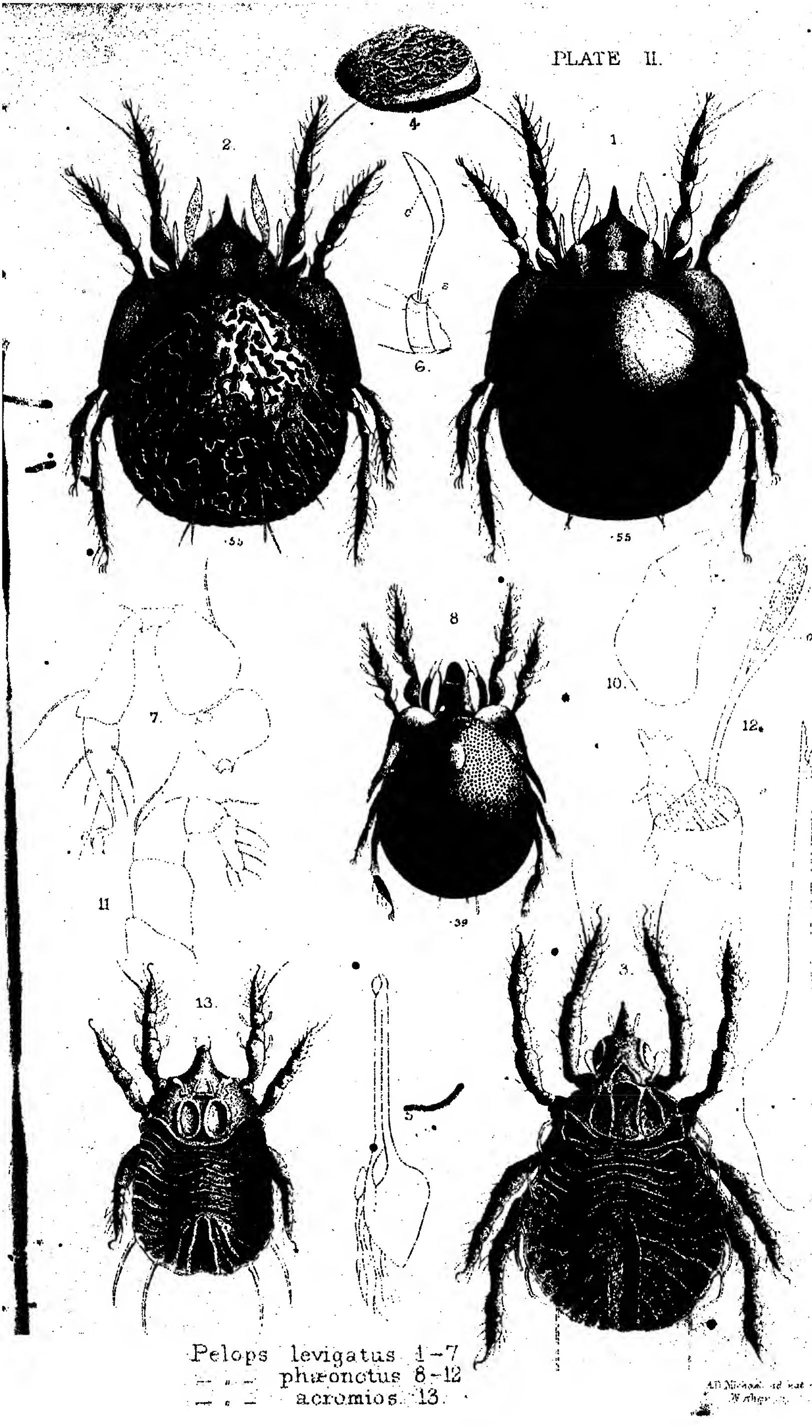
Pelops acromios. (Page 208.)

13. Larva.

* Written *levigatus* on the plate by an oversight.



Pelops levigatus 1–7
" " phæonotus 8–12
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A.D. Michael ad nat. del.

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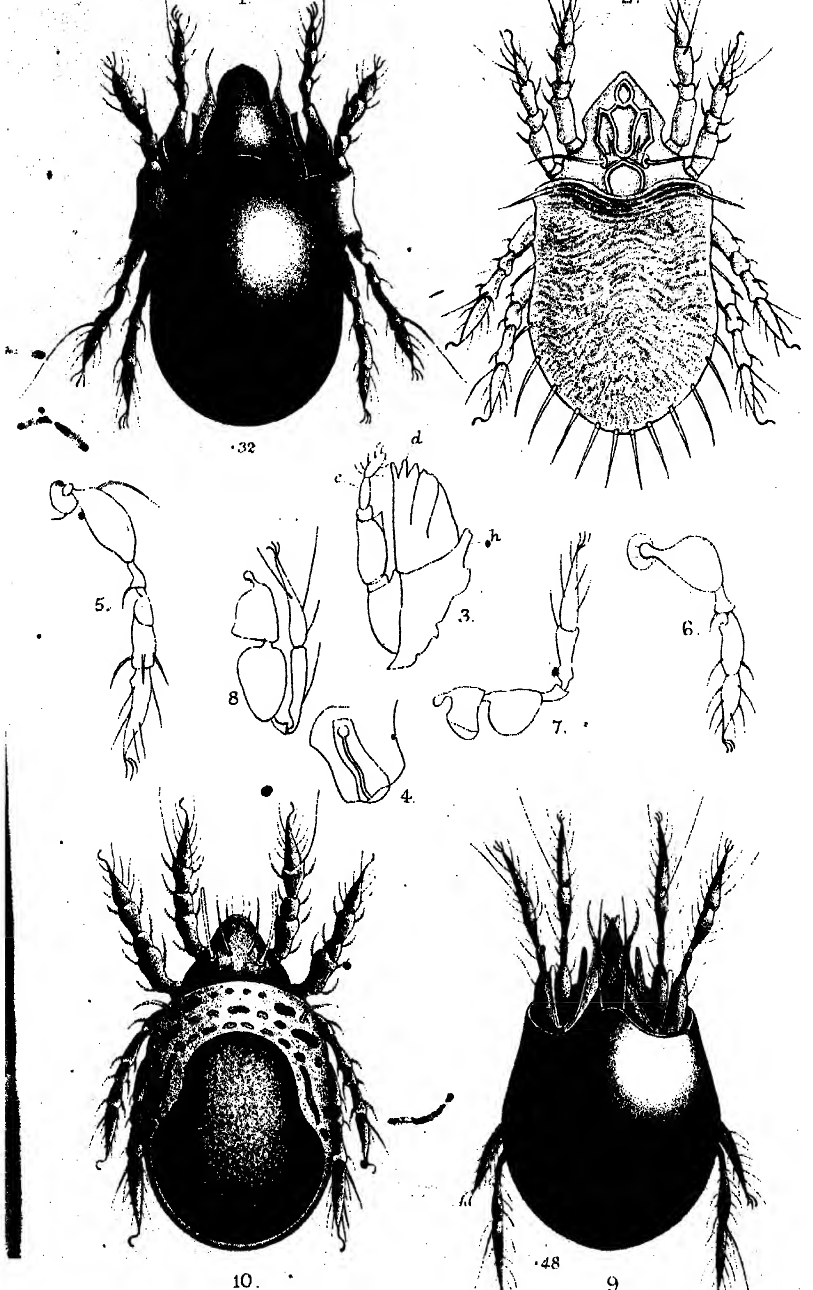
ORIBATA GRACILIS. (Page 225.)

9. Adult. × 95.
10. Nymph.

PLATE III.



A.D. Michael ad nat. del. W. Rhein lith.

Mintern Bros. imp.

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ORIBATA MOLLICOMUS.* (Page 227.)

Fig. 1. Adult. × 80.
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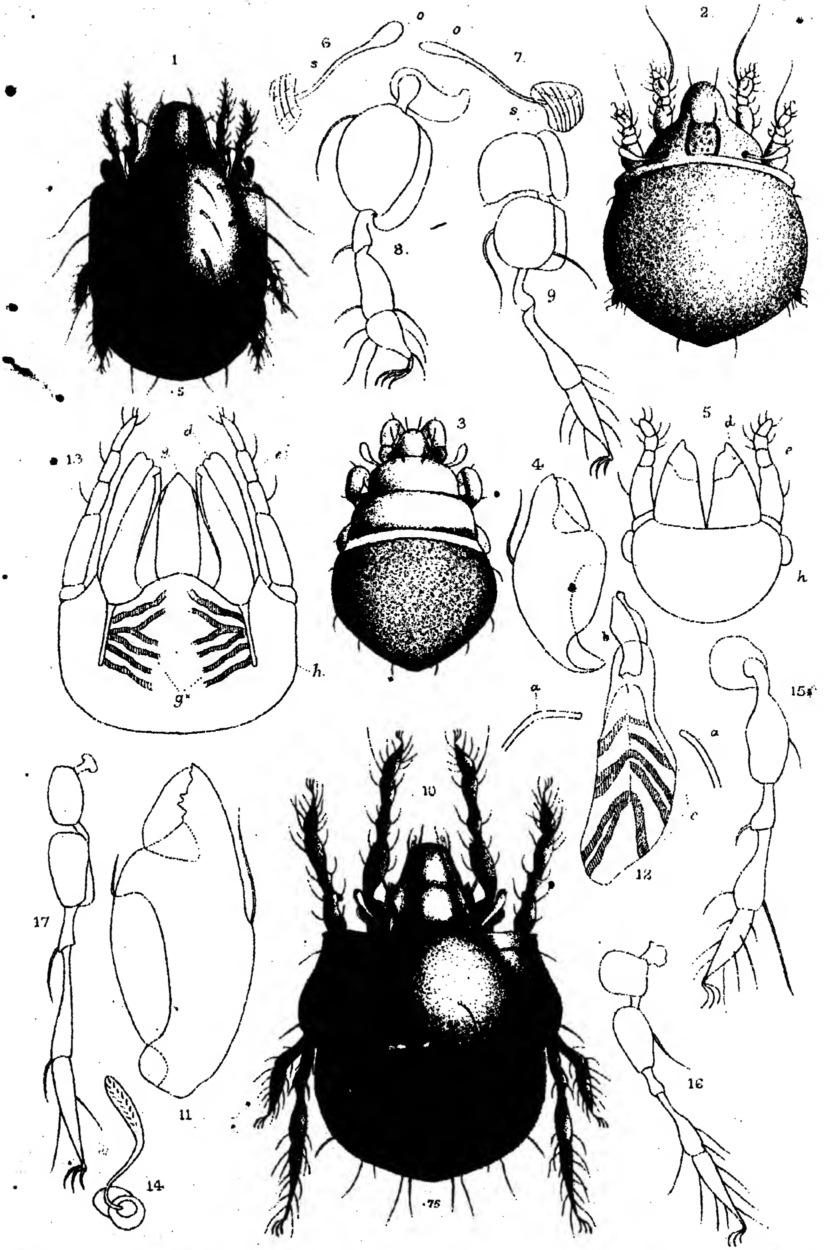
4. Adult; mandible. × 220.
5. Adult; (*h*) maxillary lip; (*d*) maxilla; (*e*) palpus. × 220.
6. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ seen from the side; × 350.
7. The same, seen on edge; × 350.
8. Adult; leg, 2nd pair. × 220.
9. Adult; leg, 4th pair. × 220.

ORIBATA EDWARDSII. (Page 229.)

10. Adult. × 65.
11. Adult; mandible. × 220.
12. Adult; the same, × 220; edge view; (*a*) edge of camerastomum; (*b*) moveable chela; (*c*) muscular bands attached to the same by tendon. (Drawn from a preparation probably not quite in natural state.)
13. Adult; (*h*) maxillary lip; (*d*) maxilla; (*g*) lingula; (*e*) palpus; (g^x) muscular bands (adductores maxillarum). × 220.
14. Adult; pseudo-stigma and pseudo-stigmatic organ. × 220.
15. Adult; leg, 1st pair. × 125.
16. Adult; leg, 3rd pair. × 125.
17. Adult; leg, 4th pair. × 125.

* Written *molicomus* on the plate by an oversight.

PLATE IV.



A.D. Michael ad nat. del. W. Rhein sc. Mintern Bros. imp.

Oribata molicomus. Figs. 1—9.
" " Edwardsii " 10—17.

PLATE V.

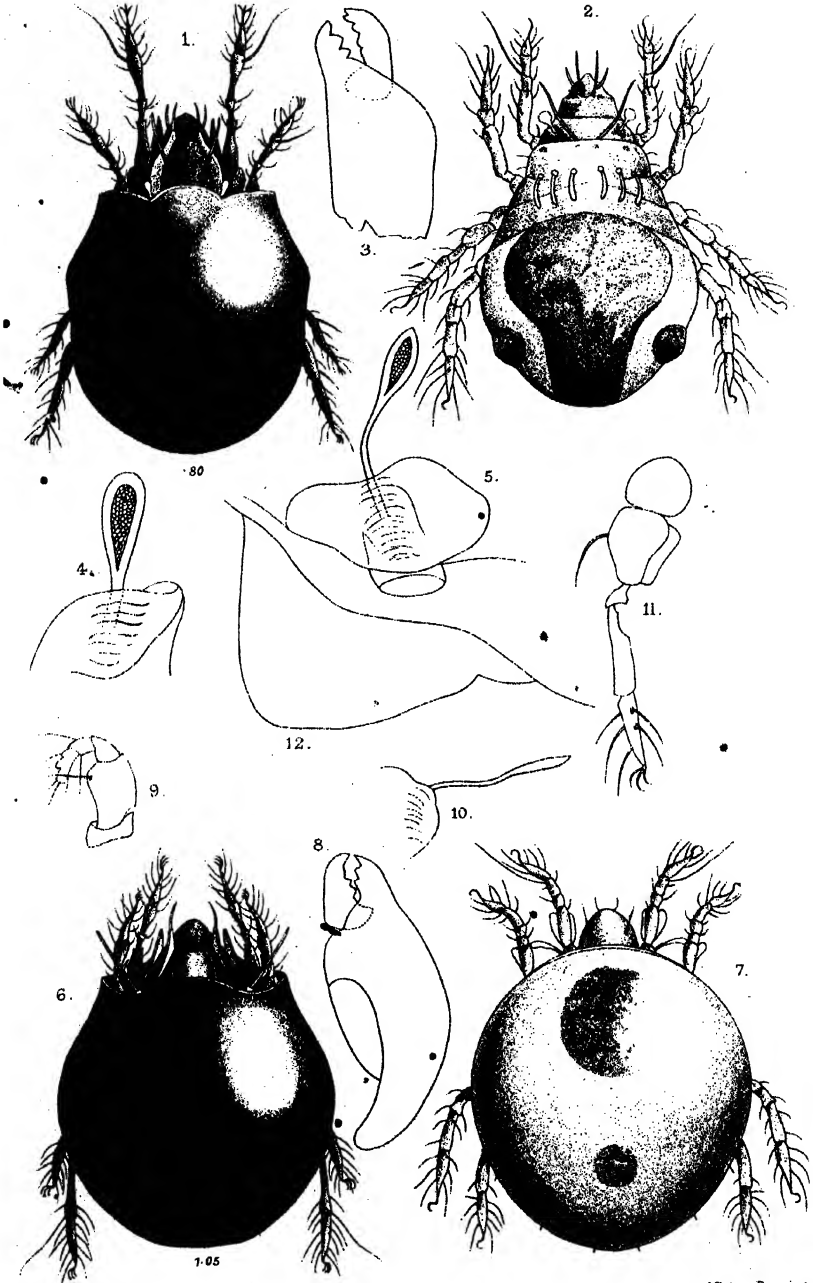
ORIBATA LAPIDARIA. (Page 230.)

Fig. 1. Adult. × 55.
2. Nymph.
3. Anterior part of mandible of adult. × 180.
4. Pseudo-stigma and pseudo-stigmatic organ of adult. × 360.
5. The same; var. *a*. × 360.

ORIBATA GLOBULA. (Page 234.)

6. Adult. × 40.
7. Nymph.
8. Mandible of adult. × 180.
9. Palpus of adult. × 180.
10. Pseudo-stigma and pseudo-stigmatic organ of adult. × 180.
11. 4th leg of adult. × 75.
12. Pteromorpha of adult. × 75.

PLATE V.



A.D. Michael ad nat. del. W.Rhein sc.

Mintern Bros imp

Oribata lapidaria Figs 1–5.
— " — globula " 6–12.

PLATE VI.

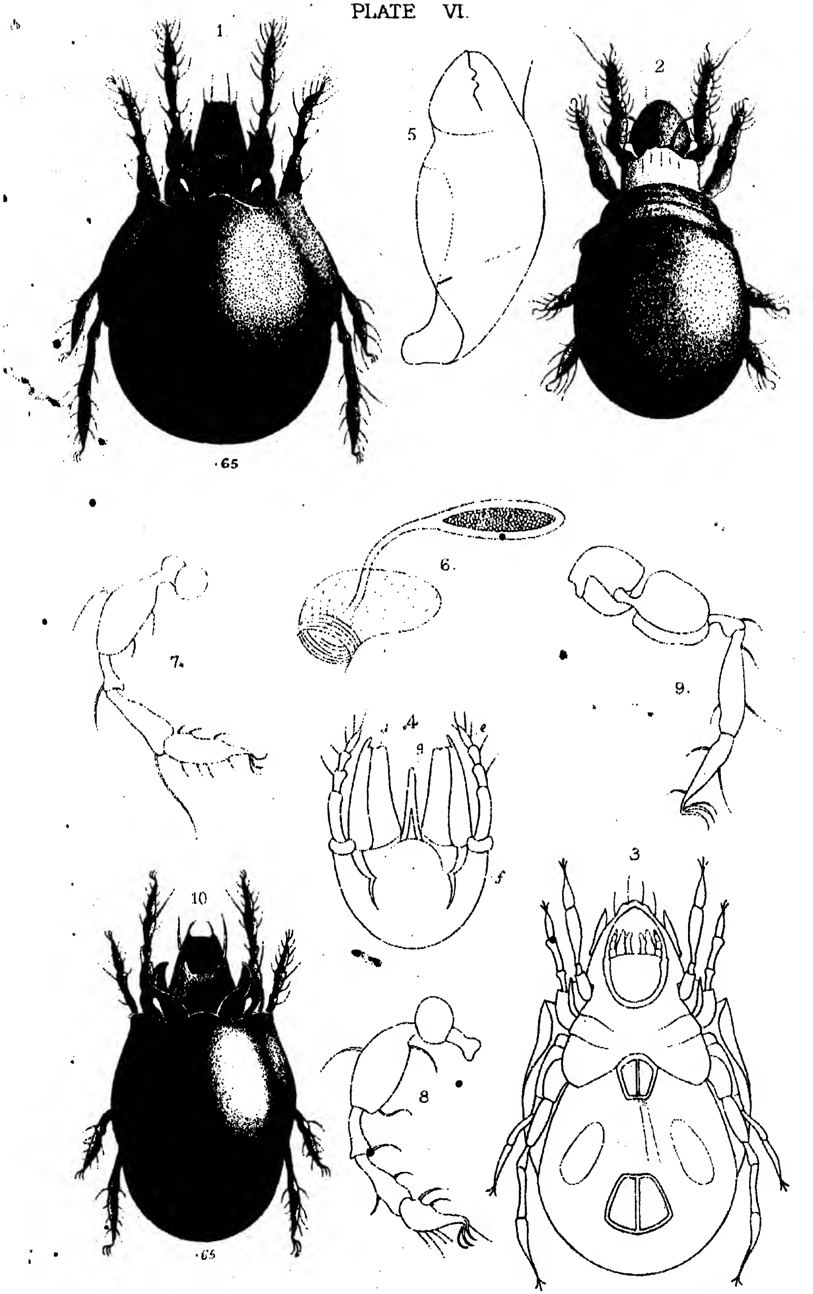
ORIBATA ORBICULARIS. (Page 236.)

Fig. 1. Adult. × 70.
3. Under side of adult. × 75.
4. Labial organs of adult; (*d*) maxillæ; (*e*) palpus; (*f*) labium; (*g*) lingula. × 220.
5. Mandible of adult. × 200.
6. Pseudo-stigma and pseudo-stigmatic organ of adult. × 360.
7. 1st leg of adult. × 125.
8. 2nd leg of adult. × 125.
9. 4th leg of adult. × 125.

ORIBATA PIRIFORMIS. (Page 238.)

10. Adult. × 60.
2. Nymph.

PLATE VI.



A.D. Michael ad nat. del. W. Rhein sc. Mintern Bros. lith.

Oribata orbicularis Figs 1–9.
— „ — piriformis „ 10.

PLATE VII.

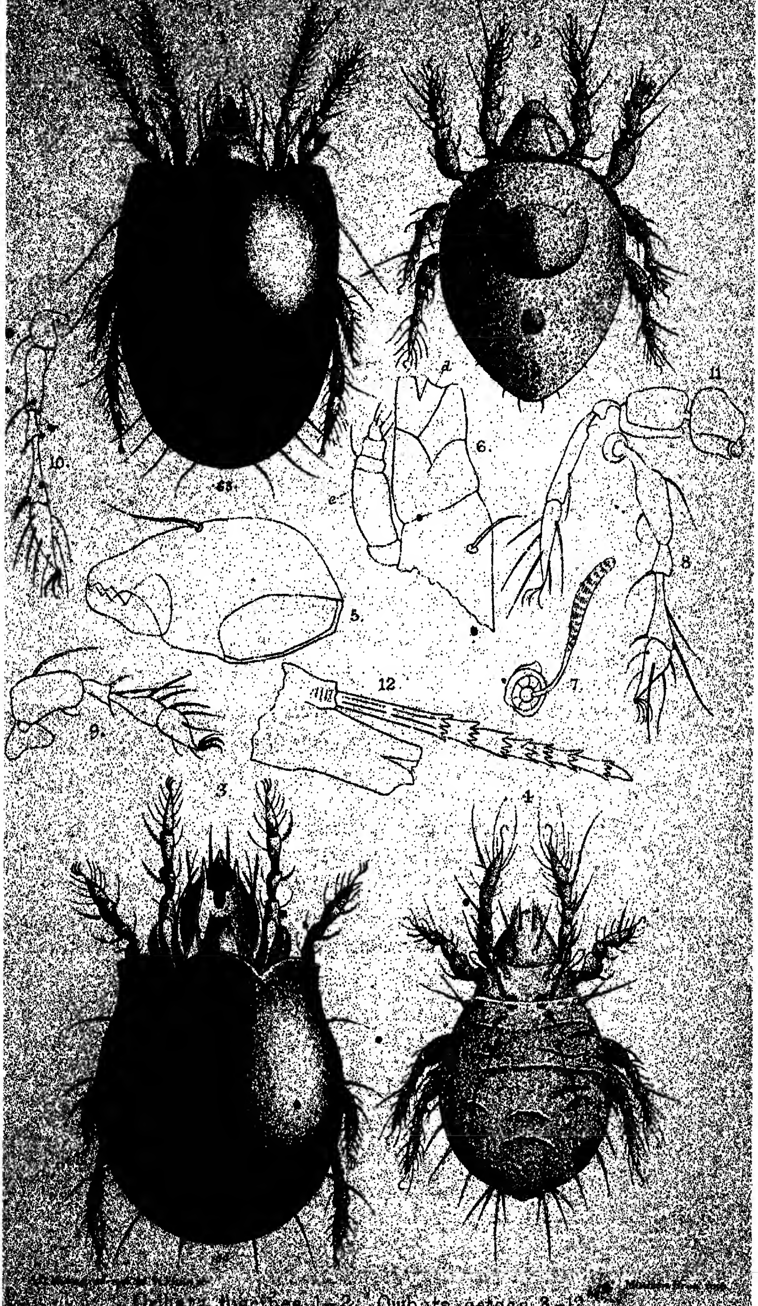
ORIBATA FUSCIPES. (Page 241.)

Fig. 1. Adult. × 80.
2. Nymph.

ORIBATA SETOSA. (Page 243.)

3. Adult. × 80.
4. Nymph.
5. Adult; mandible. × 360.
6. Adult; maxilla (*d*); and palpus (*e*). × 360.
7. Adult; pseudo-stigma and pseudo-stigmatic organ. × 360.
8. Adult; 1st leg. × 160.
9. Adult; 2nd leg. × 160.
10. Adult; 3rd leg. × 160.
11. Adult; 4th leg. × 160.
12. Adult; lamellar hair. × 650.

PLATE VI.



Oribata fuscipes 1-2. Oribata setosa 3-12.

PLATE VIII.

ORIBATA QUADRICORNUTA. (Page 247.)

Fig. 1. Adult. × 100.

2. Nymph.

3. Adult. × 100. Three-quarter view of under side; (*a*) hood of the rostrum; (*b*) greatly developed pectinated rostral hairs; (*c*) point of mandibles; (*d*) maxillæ; (*f*) labium; (*h*) cusps of right lamella; (*l*) the right lamella; (*m*) spine from centre of anterior edge of same (lamellar hair); (*n*) inter-lamellar hairs; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ; (*k*) pteromorpha; (*i*) genital plates; (*j*) anal plates, seen open; (*z*) first tectopedium; 1, 2, 3, 4, legs of the 1st, 2nd, 3rd, and 4th pairs respectively.

4. Part of mandible of adult. × 250.

5. Adult; (*h*) maxillary lip; (*d*) maxilla; (*e*) palpus. × 500.

6. Hood of the rostrum of adult, seen from the dorsal surface, but showing the buccal opening and labium through the chitin, by transparency. × 300. (*a*) Flat depressed horizontal ridge round front of rostrum; (*b*) rostral hairs.

7. Portion of the sternum of adult showing the first pair of tectopedia on edge. × 300.

8. Adult; side view of one of the same tectopedia. × 300.

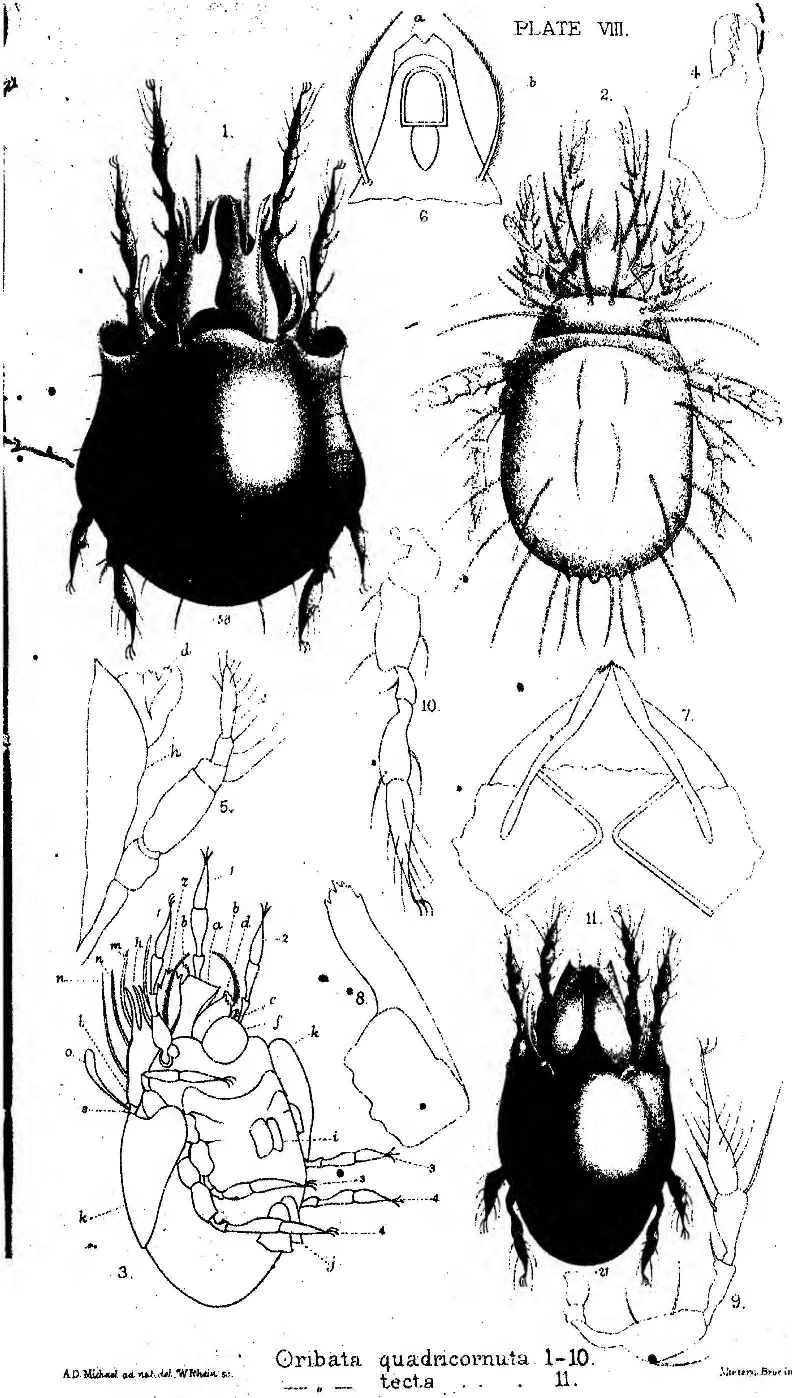
9. Adult; leg, 1st pair.

10. Adult; leg, 4th pair.

ORIBATA TECTA. (Page 251.)

11. Adult. × 200.

PLATE VIII.



Oribata quadricornuta 1–10.
— " — tecta . . . 11.

A.D. Michael ad nat. del. W. Rhein sc.

Mintern Bros imp.

PLATE IX.

ORIBATA PUNCTATA. (Page 253.)

Fig. 1. Adult. × 80.

2. Nymph.

3. Adult; under side, × 80, showing the way the legs are folded and protected by the pteromorphæ and tectopedia. (*a*) Edge of epistome (camerastomum); (*f*) labium with palpi and maxillæ showing below the same; (*u*) lamellæ; (*i*) genital plates; (*j*) anal plates; (*k*) pteromorpha; (*l*) prolonged point of same; (*m*) 2nd tectopedium; (*n*) reflexed edge of notogaster embracing the ventral plate: (1) 1st pair of legs; (2) 2nd pair of legs; (3) 3rd pair of legs; (4) 4th pair of legs.

4. Adult; rather more than side view, × 80, more of the dorsal than ventral surface being shown. Lettering the same as fig. 3, and (*d*) maxilla; (*e*) palpus; (*o*) pseudostigmatic organ; (*t*) dorso-vertex; (*v*) inter-lamellar hairs.

5. Adult; mandible. × 165.

6. Adult; (*h*) maxillary lip; (*d*) maxillæ; (*e*) palpi. × 165.

7. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 165.

8. Adult; leg of the 1st pair. × 165.

9. Adult; leg of the 3rd pair. × 165.

10. Adult; leg of the 4th pair. × 165.

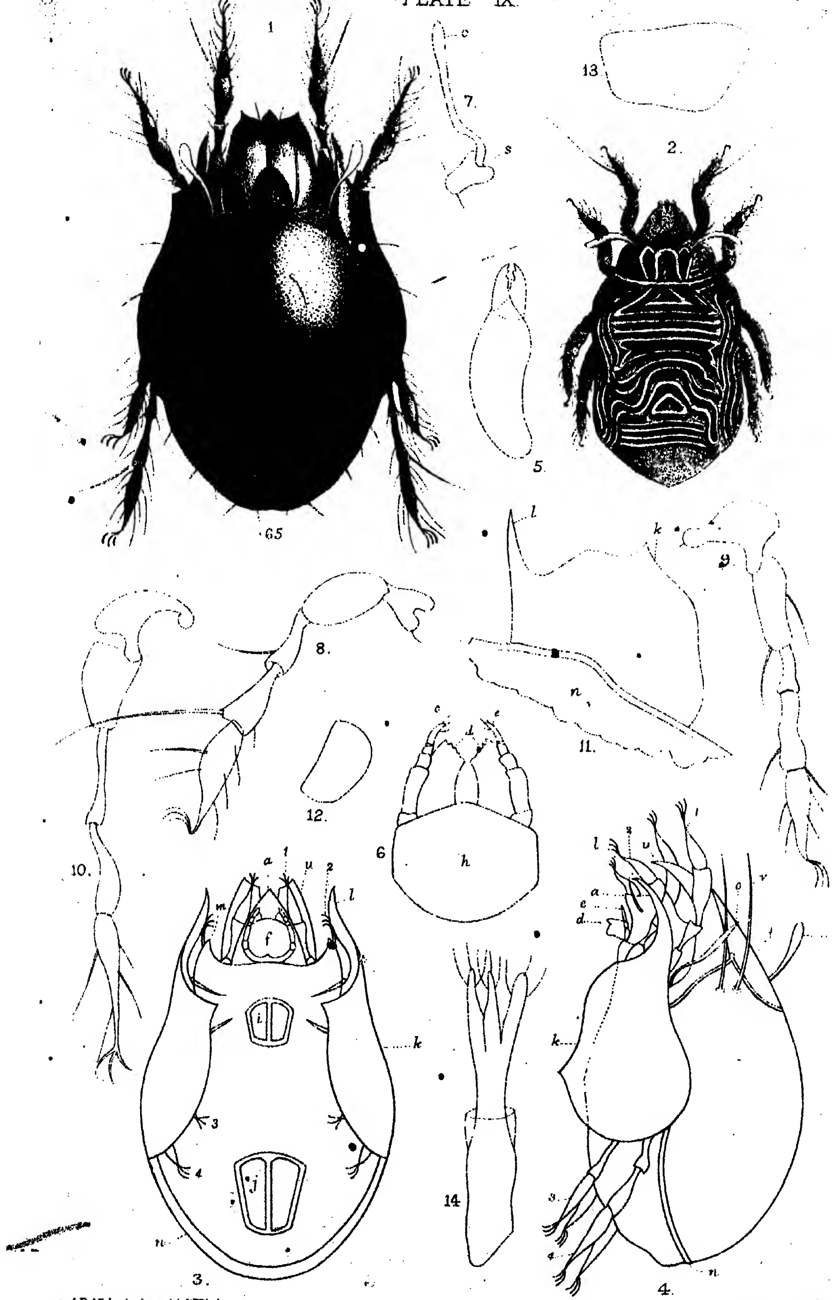
11. Adult; (*k*) pteromorpha; (*l*) prolonged point point of the same; (*n*) part of the notogastral shield. × 100.

12. Adult; one of the genital plates, seen from within, × 165.

13. Adult; one of the anal plates. × 165.

14. Adult; ovipositor of female retracted, showing the invagination (like the finger of a glove). × 165.

PLATE IX.



A.D. Michael ad nat. del. W. Rhein sc.

Mintern Bros imp.

Oribata punctata.

PLATE X.

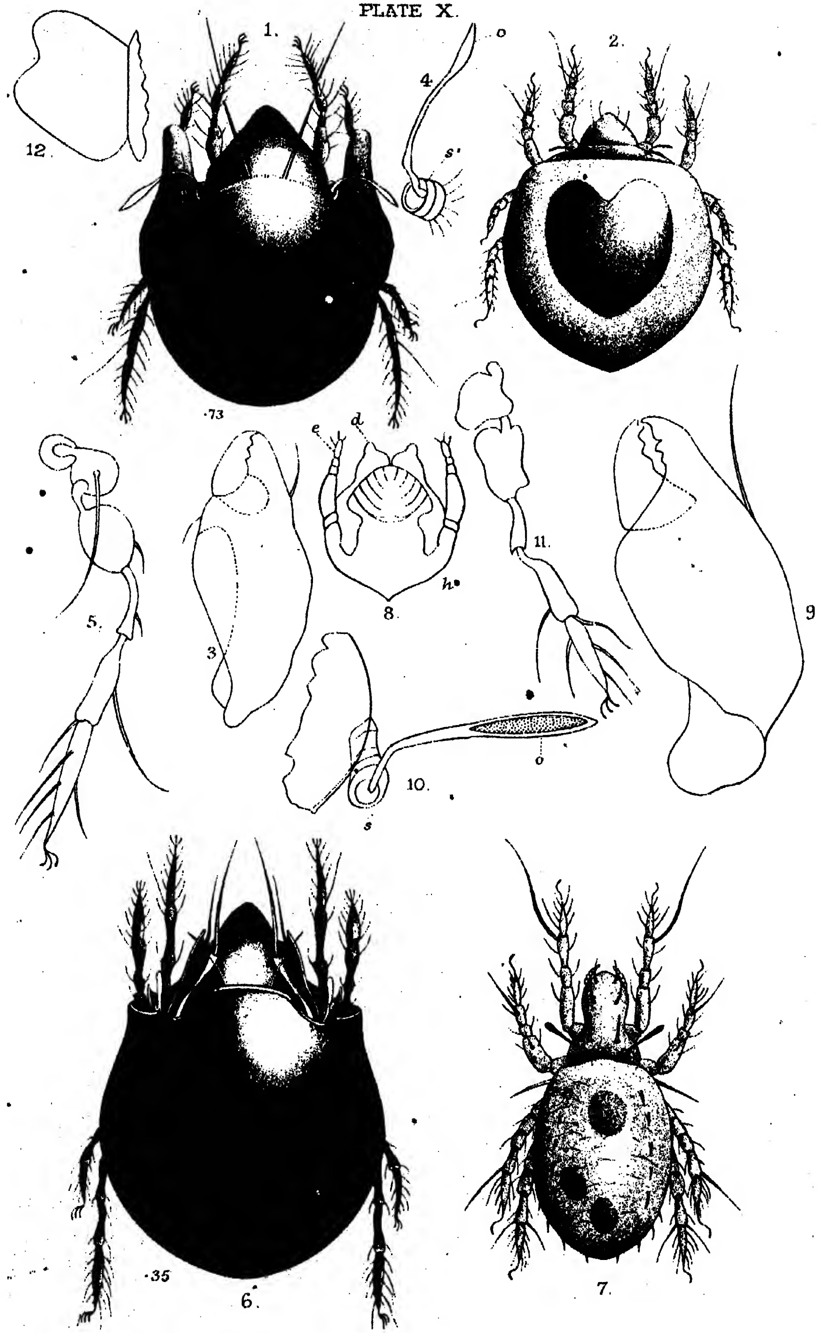
ORIBATA ALATA. (Page 257.)

Fig. 1. Adult. × 60.
2. Nymph.
3. Adult; mandible. × 200.
4. Adult; (*s*) pseudo-stigma, and (*o*) pseudo-stigmatic organ. × 200.
5. Adult; leg, 4th pair, × 125.
12. Adult; pteromorpha.

ORIBATA CUSPIDATA. (Page 260.)

6. Adult. × 150.
7. Nymph.
8. Adult; maxillary lip seen from within. × 260. (*d*) maxilla; (*e*) palpus; (*h*) lip.
9. Adult; mandible. × 550.
10. Adult; (*s*) pseudo-stigma, and (*o*) pseudo-stigmatic organ. × 550.
11. Adult; leg, 4th pair. × 260.

PLATE X.



A.D. Michael ad nat. del. W. Rhein lith

Minton Brot imp.

Oribata alata. Figs 1 – 5.
— „ — cuspidata „ 6 – 11.

PLATE XI.

Oribata Lucasii. (Page 262.)

Fig. 1. Adult. × 85.
2. Nymph.
3. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 600.
4. Adult; pteromorpha. × 250.
5. Adult; leg, 1st pair. × 250.

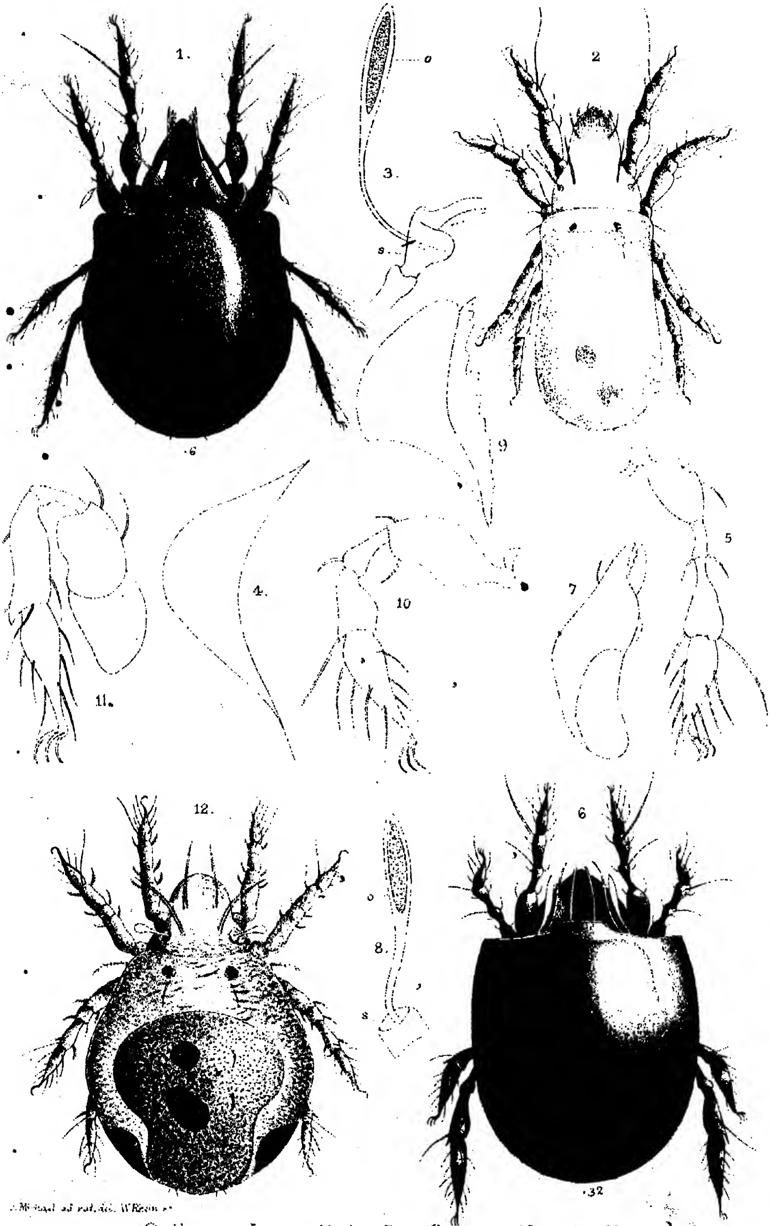
Oribata avenifera.* (Page 264.)

6. Adult. × 140.
7. Adult; mandible. × 350.
8. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 600.
9. Adult; pteromorpha. × 250.
10. Adult; leg, 1st pair. × 350.
11. Adult; leg, 4th pair. × 350.

Oribata orbicularis. (Page 236.)

12. Nymph.

* The final *a* is omitted on the plate.



Oribata Lucasii 1–5. O. avenifer 6–11.
O. orbicularis 12.

PLATE XII.

ORIBATA PARMELIÆ. (Page 265.)

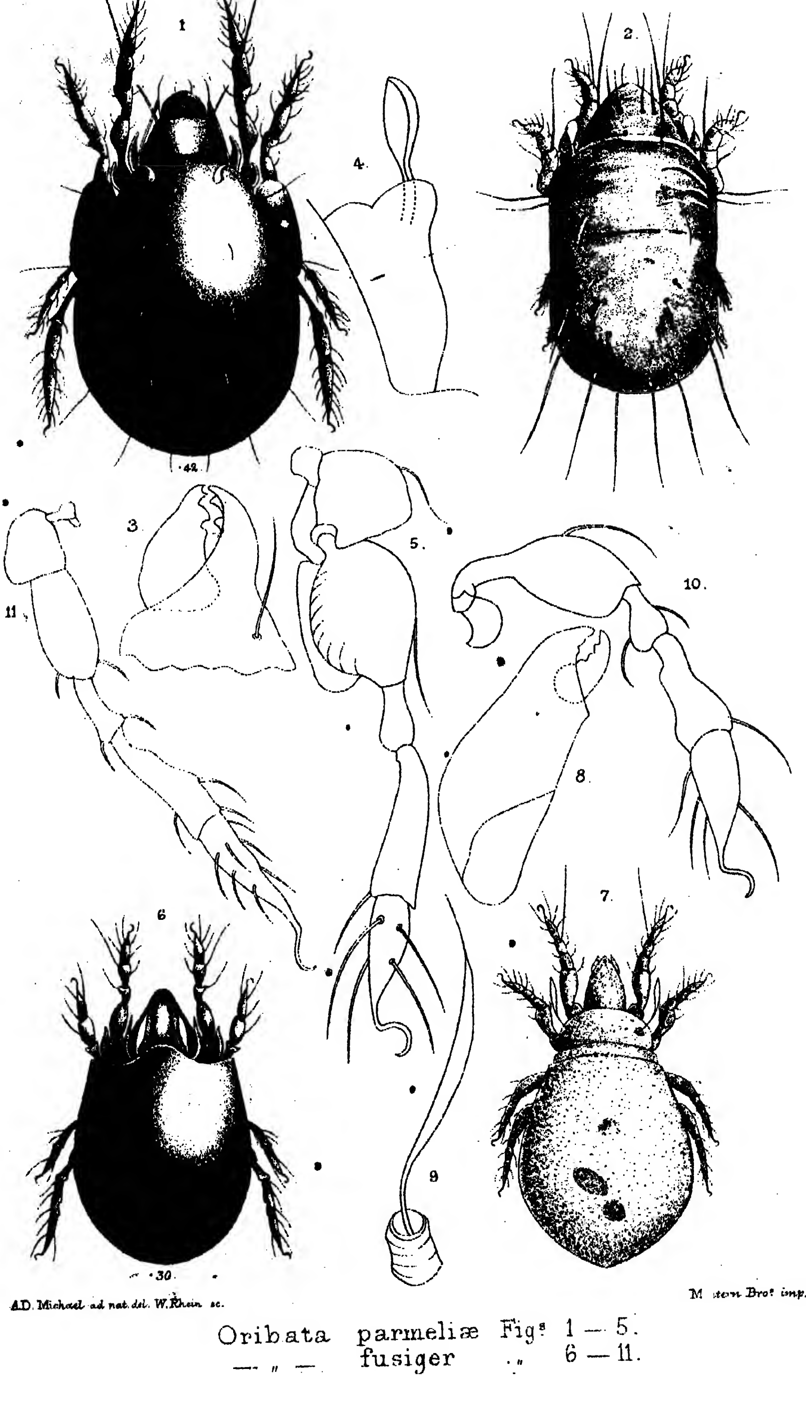
Fig. 1. Adult. × 100.
2. Nymph.
3. Adult; chela of mandible. × 430.
4. Adult; pseudo-stigma and pseudo-stigmatic organ. × 430.
5. Adult; leg, 4th pair. × 350.

ORIBATA FUSIGERA.* (Page 268.)

6. Adult. × 125.
7. Nymph.
8. Adult; mandible. × 800.
9. Adult; pseudo-stigma and pseudo-stigmatic organ, × 800.
10. Adult; leg, 1st pair. × 550.
11. Adult; leg, 4th pair. × 550.

* The final *a* is omitted on the plate.

PLATE XII.



A.D. Michael ad nat. del. W. Rhein sc.

M...ern Bro.s imp.

Oribata parmeliæ Fig.s 1 — 5.
— " — fusiger " 6 — 11.

PLATE XIII.

LEIOSOMA (CEPHEUS) SIMILE.* (Page 276.)

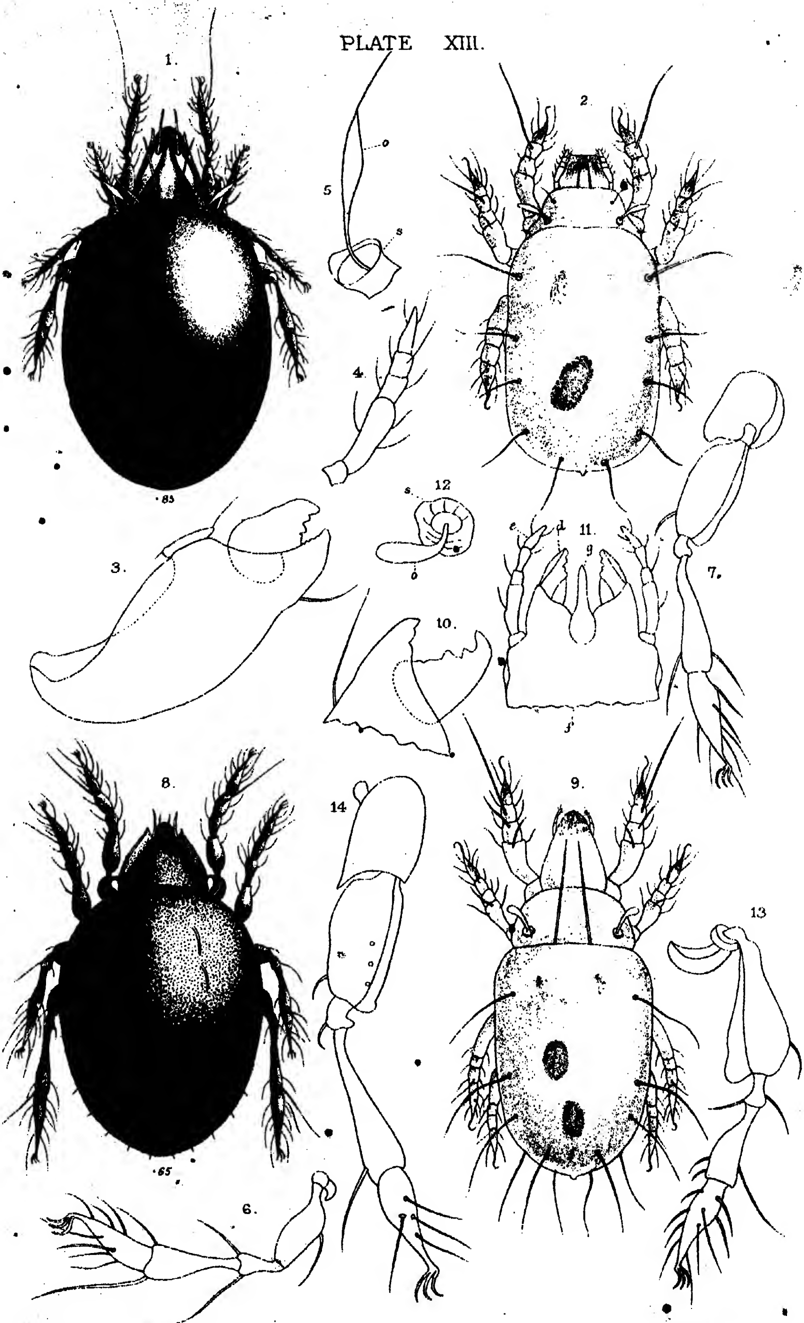
Fig. 1. Adult. × 60.
2. Nymph.
3. Adult; mandible. × 250.
4. Adult; palpus. × 250.
5. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 250.
6. Adult; 1st leg. × 120.
7. Adult; 4th leg. × 120.

LEIOSOMA (CEPHEUS) OVATUM. (Page 278.)

8. Adult. × 80.
9. Nymph.
10. Adult; chela of mandible. × 350.
11. Adult; (*d*) maxilla; (*e*) palpus; (*f*) maxillary lip; (*g*) lingula. × 200.
12. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 550.
13. Adult; leg, 1st pair, from within. × 200.
14. Adult; leg, 4th pair. × 200.

* Written *simili* on the plate by an oversight.

PLATE XIII.



A.D. Michael ad nat. del. W. Rhein sc. — Mintern Bros imp.

Leiosoma similis. Figs 1–7.
— „ — ovatum „ 8–14.

PLATE XIV.

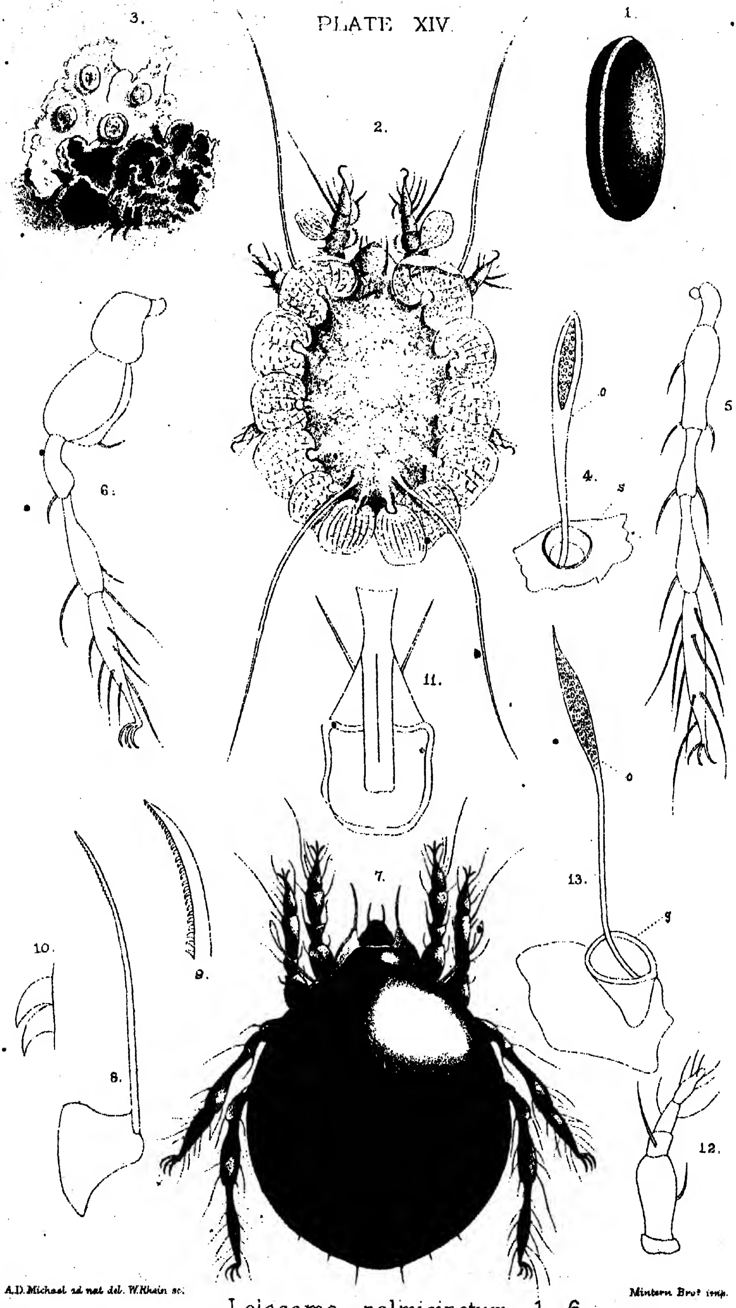
LEIOSOMA (CEPHEUS) PALMICINCTUM. (Page 280.)

Fig. 1. Egg at commencement of the deutovium stage. × 80.
2. Larva.
3. A piece of lichen with nymphs *in situ* on the underside.
4. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 500.
5. Adult; leg, 1st pair. × 120.
6. Adult; leg, 3rd pair. × 120.

SERRARIUS MICROCEPHALUS. (Page 272.)

7. Adult. × 100.
8. Adult; mandible. × 250.
9. Adult; serrated end of the same mandible. × 500.
10. Adult; two teeth of the same serrature. × 2000.
11. Adult; labium and coalesced maxillæ seen from within, the palpi having been removed. × 250.
12. Adult; palpus. × 250.
13. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 550.

PLATE XIV.



A.D. Michael ad nat del. W.Rhein sc.

Mintern Bros imp.

Leiosoma palmicinctum 1–6.
Serrarius microcephalus 7–13.

PLATE XV.

LEIOSOMA (CEPHEUS) PALMICINCTUM. (Page 280.)

Fig. 1. Nymph, × about 55. This is drawn from a fully grown specimen (dorsal aspect). The central ellipse, with the innermost set of scales attached to it, is the larval notogastral skin. The other rows of scales belong to the successive nymphal skins.

2. Nymph nearly full grown; ventral aspect. × about 30. (*a*) scales of present skin; (*b*) true edge of the body; (*c*) flattened expansion of the margin of the abdomen; (*d*) arched central part of abdomen, bearing (*e*) anal plates and (*f*) plates which will be genital in the adult; (*g*) trophi.

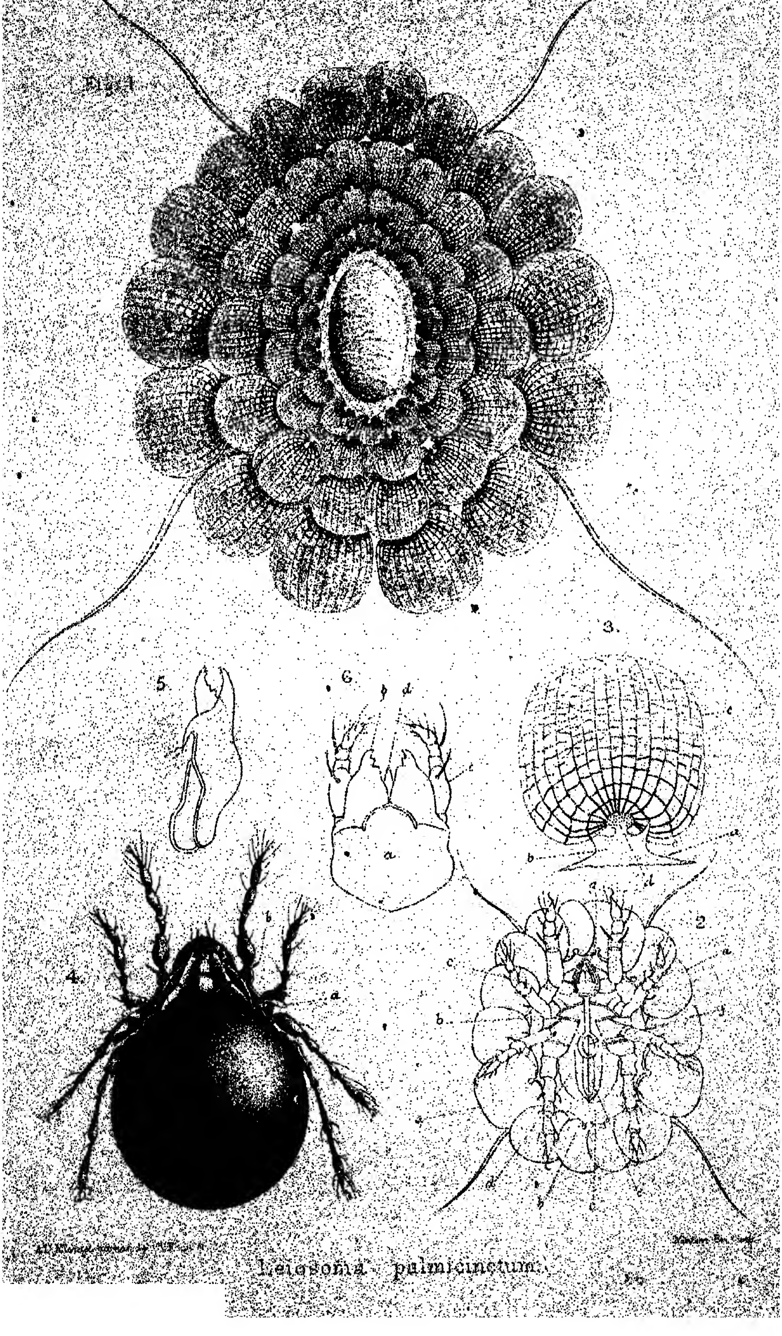
3. One of the scales or hairs. (*a*) edge of body; (*b*) brown apophysis; (*c*) lateral points of apophysis; (*d*) colourless dotted head of central part of apophysis; (*e*) membranous expansion with black nervures.

4. Adult. × 40. (*a*) Pseudo-stigmatic organs; (*b*) inter-lamellar hairs.

5. Adult; mandible. × 115.

6. Adult; (*a*) labium; (*b*) maxilla; (*c*) palpus; (*d*) lingula. × 115.

PLATE XV.



Leiosoma palmicinctum.

PLATE XVI.

Cepheus ocellatus. (Page 287.)

Fig. 1. Adult. × 80.
2. Nymph, not quite full grown; showing larval, and two nymphal, cast notogastral skins; the bordering scales of the existing skin not having yet passed far beyond those of the former skin.
3. Adult; mandible. × 370.
4. Adult; palpus. × 370.
5. Adult; pseudo-stigma and pseudo-stigmatic organ. × 370.
6. Adult; leg, 1st pair. × 170.
7. Adult; claw, 3rd pair. × 750.

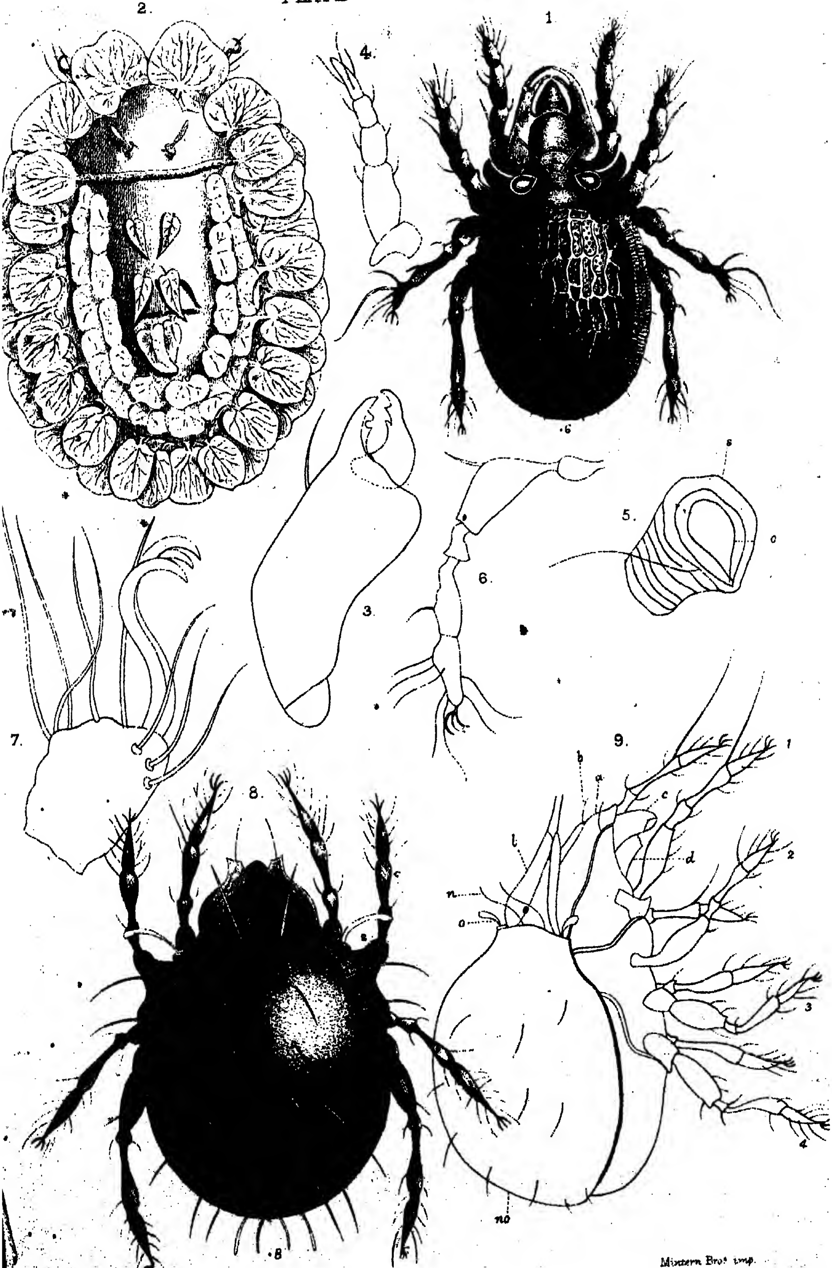
Cepheus bifidatus. (Page 290.)

8. Adult. × 62.

Cepheus tegeocranus. (Page 292.)

9. Adult. × 70, side view; (*a*) hood of rostrum; (*b*) rostral hairs; (*c*) right mandible extruded; (*d*) maxilla; (*l*) lamella; (*o*) pseudo-stigmatic organ; (*n*) interlamellar hairs; (1, 2, 3, 4), right legs of the 1st, 2nd, 3rd, and 4th pairs; (*no*) the notogaster.

PLATE XVI



A.D. Michael ad nat del. W.Rhein sc.

Mintern Bros imp.

Cepheus ocellatus 1—7.
—„— bifidatus 8.
—„— tegeocranus 9.

PLATE XVII.

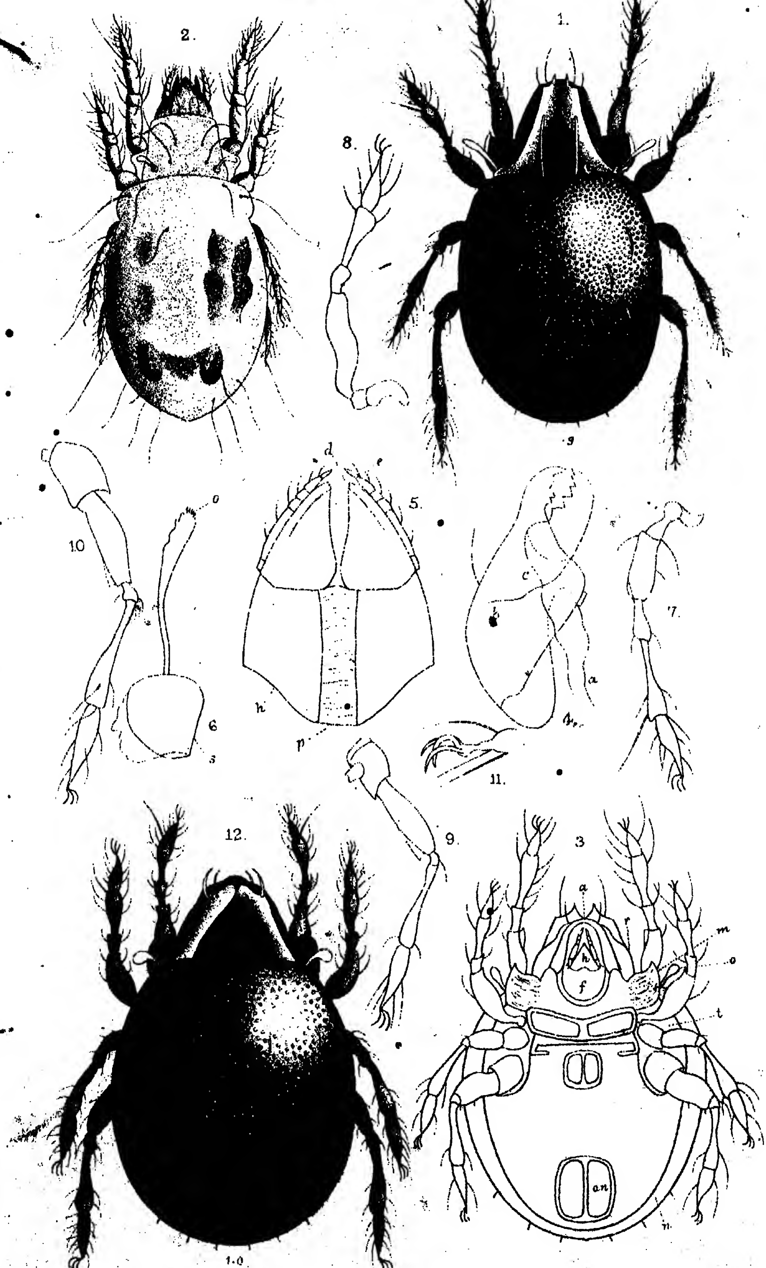
CEPHEUS TEGEOCRANUS. (Page 292.)

Fig. 1. Adult. × 70.
2. Nymph.
3. Adult, under side, × 70; (*a*) epistome (edge of camerastomum; (*f*) labium; (*h*) maxillary lip; (*r*) first tectopedium; (*m*) second ditto; (*o*) pseudo-stigmatic organ; (*n*) reflexed edge of the notogastral plate embracing the ventral; (*t*) depressed area in which the last three legs are inserted; (*an*) anal plates.
4. Adult; mandible. × 160; (*a*) tendon for retraction of the whole mandible; (*b*) tendon for opening the chelæ; (*c*) tendon for closing the same; seen through the chitin.
5. Adult; (*h*) maxillary lip; (*d*) maxillæ; (*e*) palpus; (*p*) pharynx.
6. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 270.
7. Adult; leg, 1st pair. × 85.
8. Adult; leg, 2nd pair. × 85.
9. Adult; leg, 3rd pair. × 85.
10. Adult; leg, 4th pair. × 85.
11. Adult; one of the claws. × 270.

CEPHEUS LATUS. (Page 295.)

12. Adult. × 55.

PLATE XVII.



A.D. Michael ad nat. del. W. Hasin sc.

Mintern Bros imp.

Cepheus tegeocranus. 1 _ 11.
— „ — latus. 12.

PLATE XVIII.

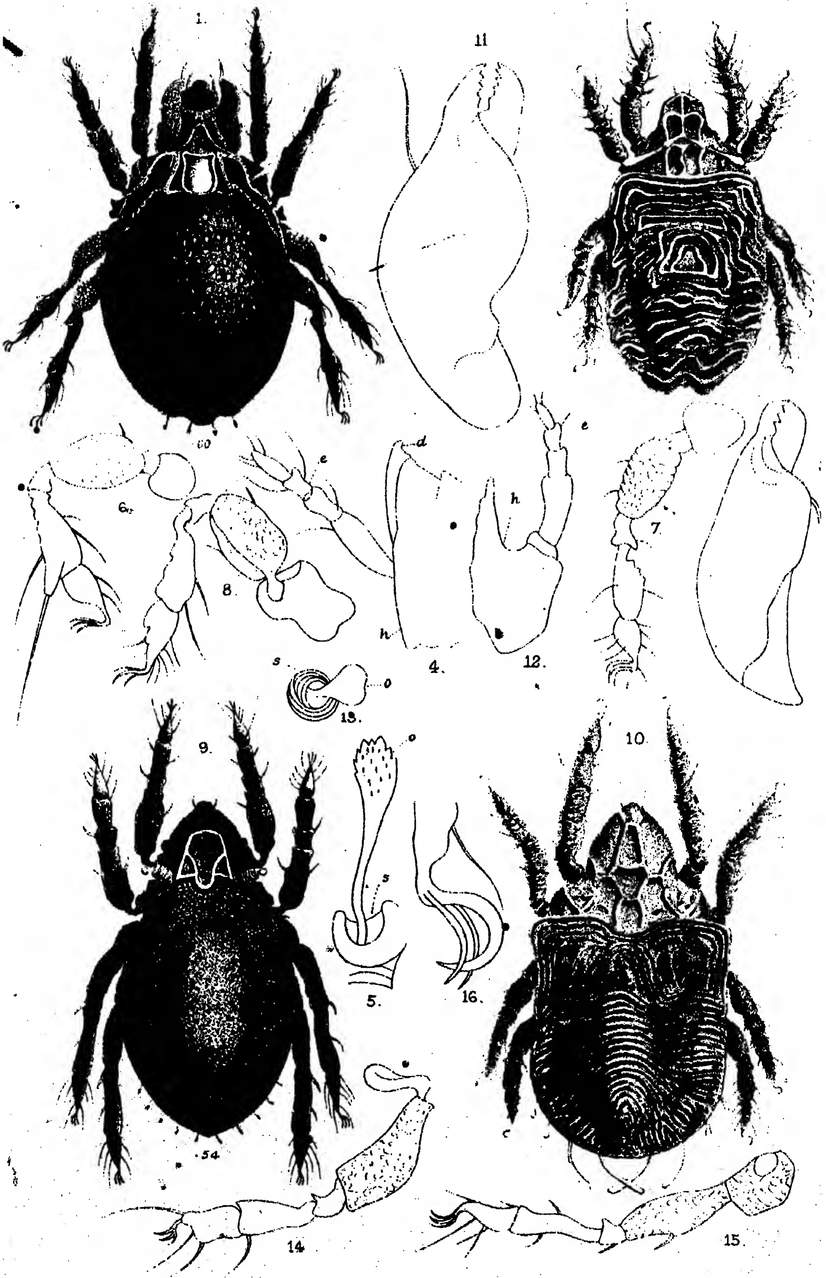
Scutovertex sculptus. (Page 299.)

Fig. 1. Adult. × 65.
2. Nymph.
3. Adult; mandible. × 325.
4. Adult; (*h*) maxillary lip from within; (*d*) maxilla; (*e*) palpus not showing basal joint. × 325.
5. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 325.
6. Adult; leg of the 1st pair. × 140.
7. Adult; leg of the 2nd pair. × 140.
8. Adult; leg of the 4th pair. × 140.

Scutovertex maculatus. (Page 302.)

9. Adult. × 85.
10. Nymph.
11. Adult; mandible. × 370.
12. Adult; (*h*) maxillary lip; (*e*) palpus. × 370.
13. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 370.
14. Adult; leg of the 2nd pair. × 170.
15. Adult; leg of the 3rd pair. × 170.
16. Adult; ungues. × 500.

PLATE XVIII.



A.D. Michael ad nat. del. W. Rhain sc.

Minturn Bros imp.

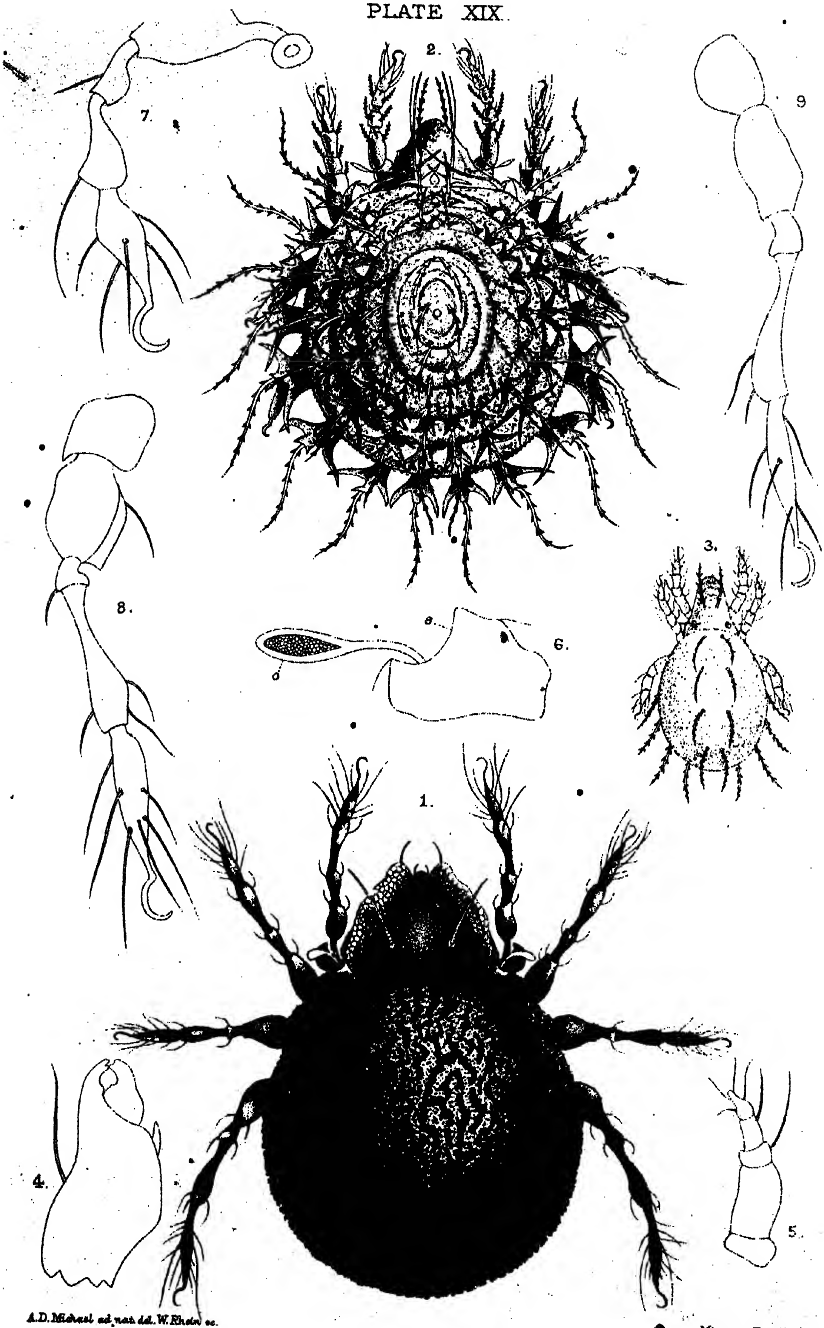
Scutovertex sculptus, Figs 1 – 8.
— „ — maculatus. „ 9 – 16.

PLATE XIX.

Tegeocranus latus. (Page 310.)

Fig. 1. Adult. × 65.
2. Nymph, full grown.
3. Larva.
4. Adult; chela of mandible. × 300.
5. Adult; palpus. × 380.
6. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 380.
7. Adult; leg, 1st pair. × 180.
8. Adult; leg, 3rd pair. × 180.
9. Adult; leg, 4th pair. × 180.

PLATE XIX.



A.D. Michael ad nat. del. W. Rhein sc.

Mintern Bros imp.

Tegeocranus. latus.

PLATE XX.

TEGEOCRANUS CORIACEUS. (Page 316.)

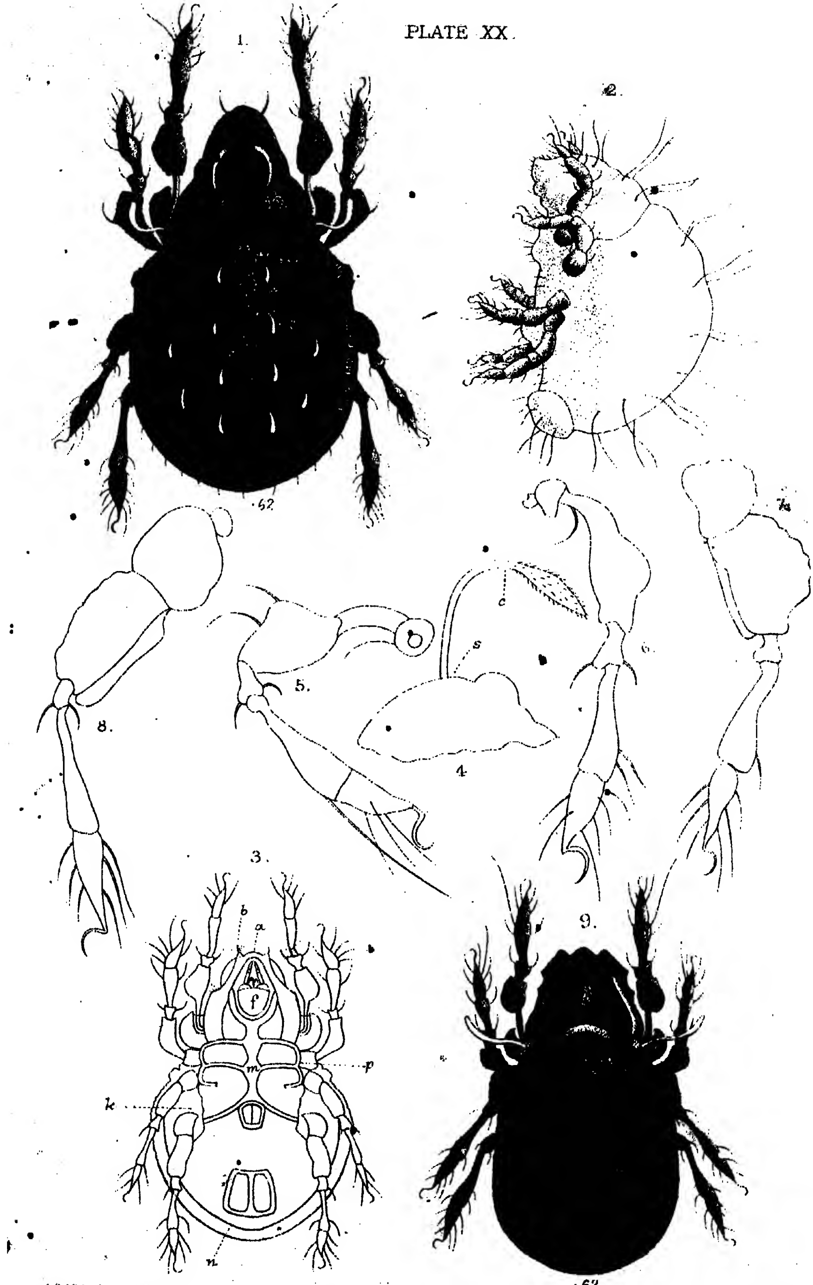
Fig. 1. Adult. × 90.

2. Nymph.
3. Adult, under side; × 65. (*a*) epistome; (*b*) rostral hairs; (*f*) labium; (*n*) reflexed edge of notogastral plate embracing the ventral; (*k*) depressed area of the ventral plate in which the last three pairs of legs are set; (*m*) sternum; (*p*) apodemata.
4. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 500.
5. Adult; leg, 1st pair, from within. × 220.
6. Adult; leg, 2nd pair, from without. × 220.
7. Adult; leg, 3rd pair, from without. × 220.
8. Adult; leg, 4th pair, from without. × 220.

TEGEOCRANUS FEMORALIS. (Page 318.)

9. Adult. × 70.

PLATE XX.



A.D. Michael ad nat. del. W. Rhein sc. Mintern Bros. imp.

Tegeocranus coriaceus 1 _ 8.
—— " —— femoralis 9.

PLATE XXI.

TEGEOCRANUS LABYRINTHICUS. (Page 319.)

Fig. 1. Adult. × 90.
2. Nymph (young).
3. Adult; part of the mandible. × 500.
4. Adult; (*h*) half of maxillary lip; (*d*) maxilla; (*e*) palpus. × 280.
6. Adult; leg, 1st pair. × 280.
7. Adult; leg, 2nd pair. × 280.
8. Adult; leg, 4th pair. × 280.

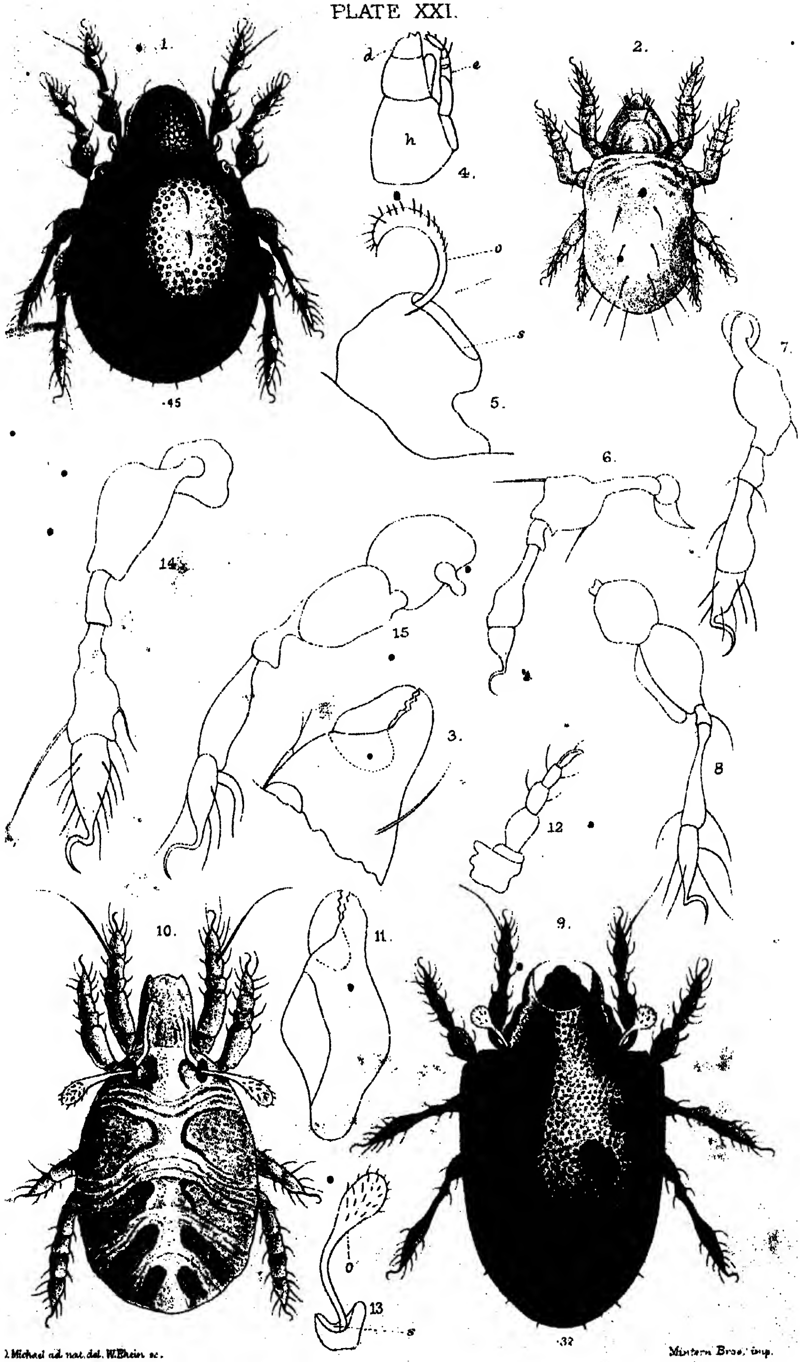
TEGEOCRANUS MARGINATUS. (Page 322.)

5. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 500.

TEGEOCRANUS VELATUS. (Page 313.)

9. Adult. × 140.
10. Nymph.
11. Adult; mandible. × 425.
12. Adult; palpus. × 425.
13. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 425.
14. Adult; leg, 1st pair. × 425.
15. Adult; leg, 4th pair. × 425.

PLATE XXI.



Michael ad. nat. del. W. Rhein sc.

Mintern Bros. imp.

Tegeocranus labyrinthicus 1 _ 8.

— „ — velatus 9 _ 15.

PLATE XXII.

TEGEOCRANUS MARGINATUS. (Page 322.)

Fig. 1. Adult. × 90.
2. Nymph.

TEGEOCRANUS LABYRINTHICUS. (Page 319.)

3. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 450.

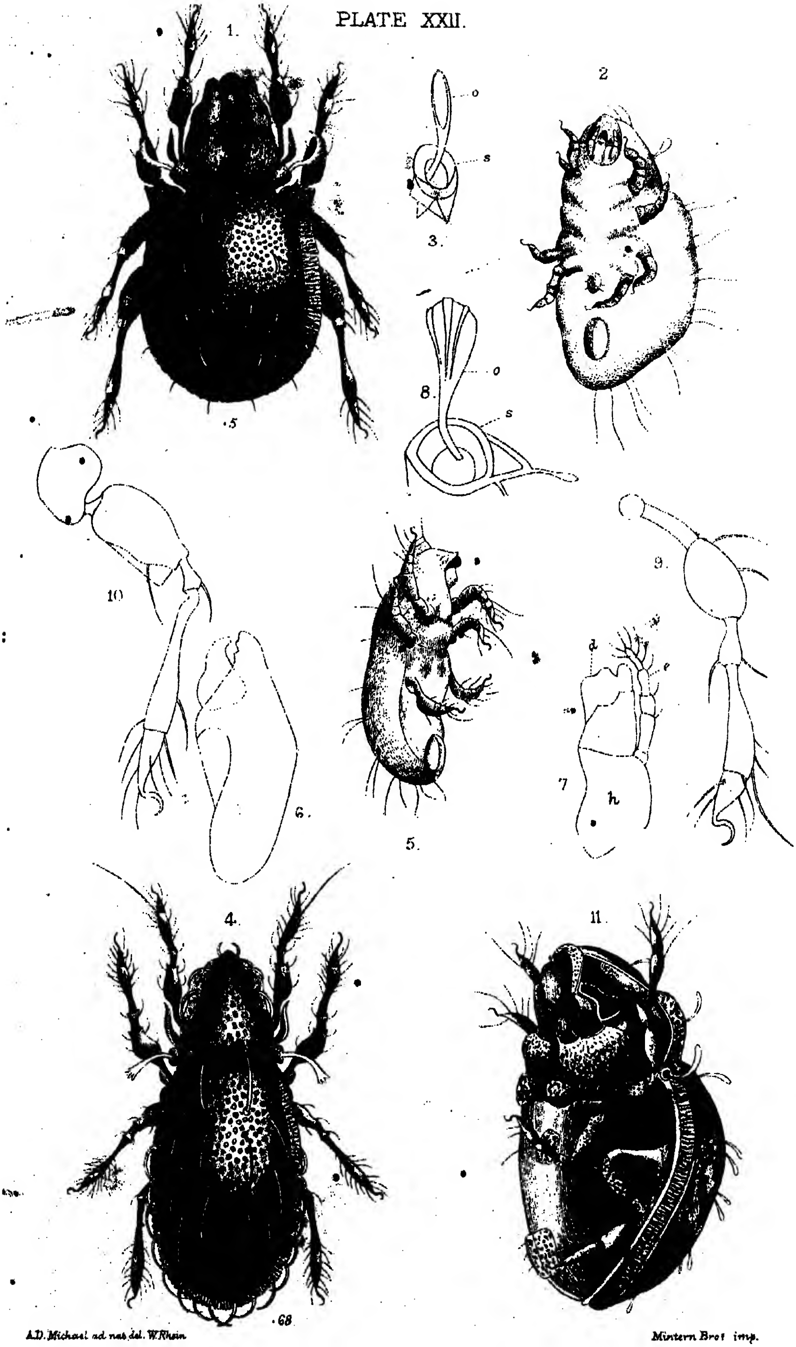
TEGEOCRANUS ELONGATUS. (Page 324.)

4. Adult. × 70.
5. Larva.
6. Adult; mandible. × 220.
7. Adult; (*h*) portion of labium; (*d*) maxilla; (*e*) palpus. × 220.
8. Adult; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ. × 500.
9. Adult; leg, 1st pair. × 220.
10. Adult; leg, 4th pair. × 220.

TEGEOCRANUS CORIACEUS. (Page 316.)

11. Adult; three-quarter ventral view. × 80.

PLATE XXII.



A.D. Michael ad nat del. W.Rhein

Mintern Bros imp.

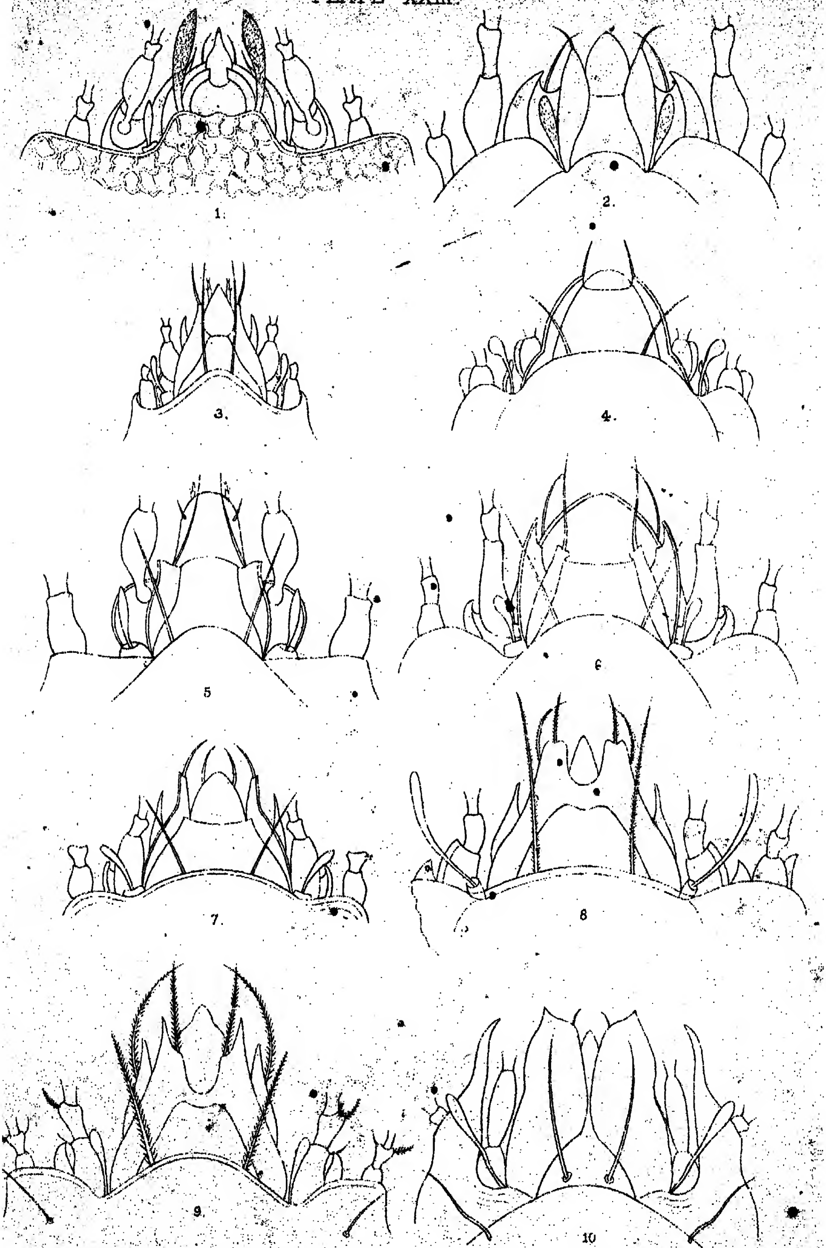
Tegeocranus marginatus 1–2. T. labyrinthicus 3.
— " — elongatus 4–10. T. coriaceus 11.

PLATE XXIII.

Outlines of cephalo-thoraces, for identification. Genera PELOPS *and* ORIBATA.

Fig. 1. PELOPS ACROMIOS. (Page 208.)
2. — PHÆONOTUS. (Page 216.)
3. ORIBATA GRACILIS. (Page 225.)
4. — MOLLICOMUS. (Page 227.)
5. — EDWARDSII. (Page 229.)
6. — LAPIDARIA. (Page 230.)
7. — GLOBULA. (Page 234.)
8. — FUSCIPES. (Page 241.)
9. — SETOSA. (Page 243.)
10. — PUNCTATA. (Page 253.)

PLATE XXIII.



A.D. Michael ad nat. del. W. Rhein sc. Mintern Bros imp.

Outlines of cephalo-thoraces.

PLATE XXIV.

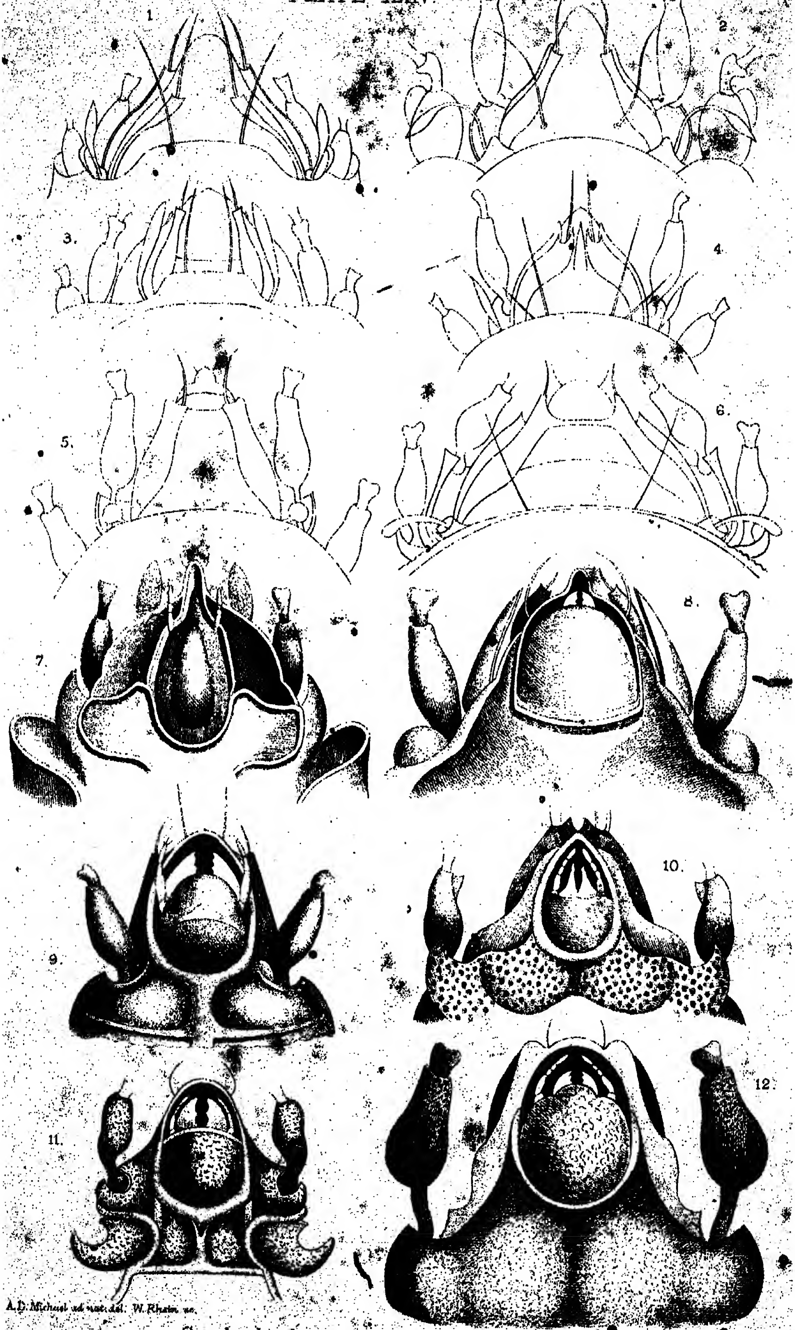
Outlines of cephalo-thoraces, for identification. Genera ORIBATA *and* LEIOSOMA (CEPHEUS).

Fig. 1.	ORIBATA CUSPIDATA.	(Page 260.)
2.	— LUCASII.	(Page 262.)
3.	— AVENIFERA.	(Page 264.)
4.	LEIOSOMA (CEPHEUS) SIMILE.	(Page 276.)
5.	— — OVATUM.	(Page 278.)
6.	— — PALMICINCTUM.	(Page 280.)

Labia, &c., illustrative of genera.

7.	PELOPS ACROMIOS.	(Page 208.)
8.	ORIBATA GLOBULA.	(Page 234.)
9.	LEIOSOMA (CEPHEUS) SIMILE.	(Page 276.)
10.	CEPHEUS TEGEOCRANUS.	(Page 292.)
11.	SCUTOVERTEX SCULPTUS.	(Page 299.)
12.	TEGEOCRANUS CORIACEUS.	(Page 316.)

PLATE XXIV



A. D. Michael ad nat. del. W. Rhein sc.

Cephalothoraces and Labia.

PLATE A.

Exo-skeleton.

Fig. 1. Outline of the cephalothorax of *Oribata piriformis* seen from above. ×125. (*a*) Hood (*r*) first tectopedium; (*m*) second ditto. This is drawn from a large specimen.

2. Half of the maxillary lip (or labium) of *Oribata piriformis* seen from below (without). × 350. (*f*) Labium; (*ff*) hinge of same; (*d*) maxilla; (*d d*) outline of internal portion of ditto (seen through the labium) in which the muscles are inserted. The arrow points to the part where the palpus would be attached.

3. Distal portion of same maxilla, seen from within; showing the denticulation.

4. The palpus of *Oribata piriformis*. × 350. The joints are numbered, commencing with the proximal and ending with the distal joint.

5. The right mandible of *Oribata piriformis* seen from the left side. (A) Moveable limb; (B) fixed ditto; (C) chitinous projection for the attachment of the tendon of the retractor muscles; (D) hollow allowing the passage of the muscles into the interior of the mandible.

6. Cephalothorax of *Oribata piriformis*. × 125. Three-quarter view, legs having been removed. (*a*) Hood of rostrum; (*t*) dorso-vertex; (*l*) lamellæ, joined by the cross ridge (trans-lamella) anteriorly; (*r*) first tectopedium; (*p*) acetabulum for the insertion of the coxa of the first leg; (*s*) pseudo-stigma; (*o*) pseudo-stigmatic organ; (*b*) rostral hair; (*k*) lamellar hair.

7. The same seen from above, but artificially flattened out to show how the first leg is protected by the lamella and first tecto-pedium. On the right side the leg is in the position it occupies when the creature fears danger. On the left side the leg has been removed. Same lettering as in last figure.

8. *Oribata piriformis* seen from above, the notogaster and the legs having been removed to show the internal arrangement of the ventral plate. × 50. Same lettering as last two plates and (*m*) second tectopedium; (*ap*) apodemata; (*i*) genital plates; (*j*) anal plates.

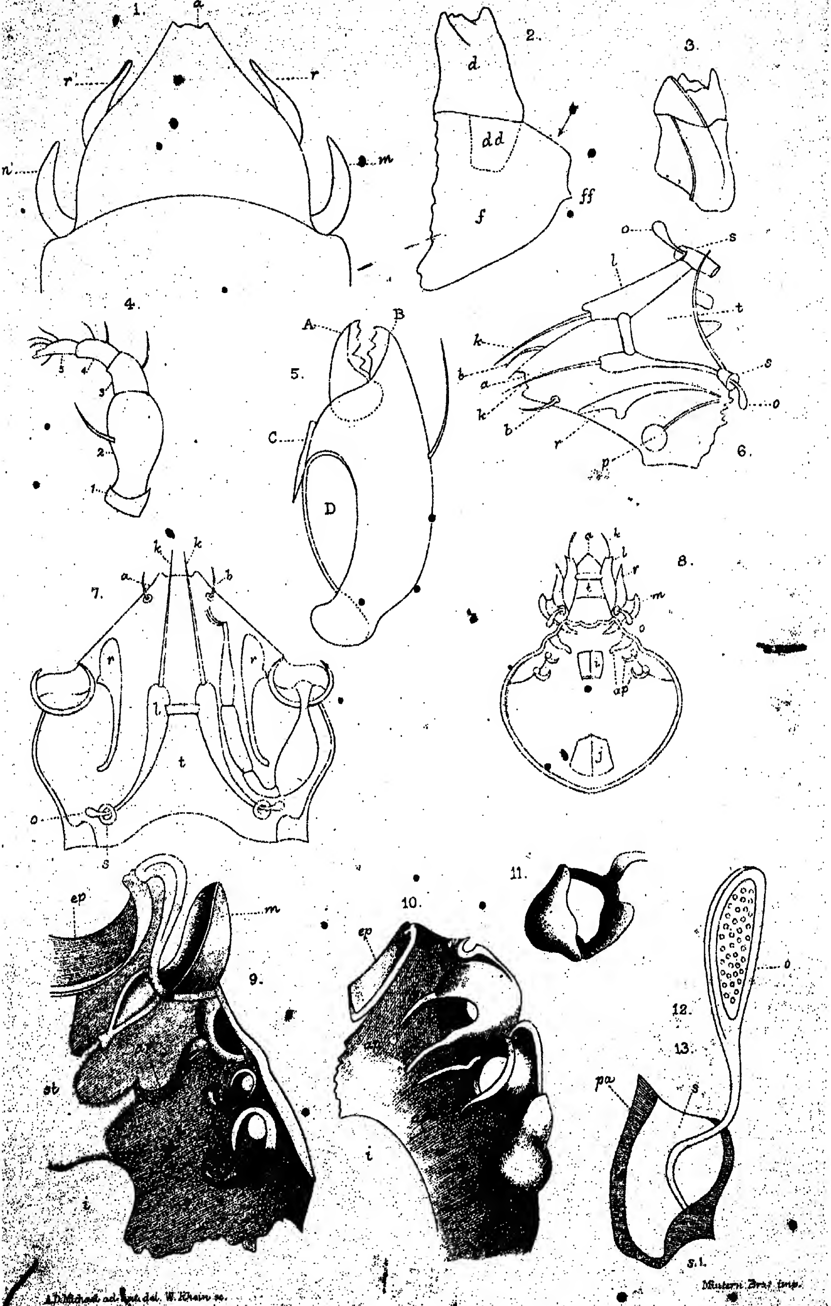
9. Anterior portion of the right side of the ventral plate of *Oribata piriformis* seen from above (within) to show the apodemata and sternum, and basilar cavities (acetabula) for the insertion of the legs. × 250. (*ep*) Epistome; (*m*) second tectopedium; (*st*) sternum; (*i*) genital opening; (*ap*) apodemata.

10. The same part in *Nothrus theleproctus*. Same lettering.

11. Cavity for the insertion of the 4th leg of *Oribata piriformis*, and acetabulum of same, and apodema, seen from within; but looking transversely at it, not from behind. × 250.

12 Whole pseudo-stigmatic organ, and 13, section of the pseudo-stigma of *Oribata piriformis*. × 700. (*pa*) Parietes of the pseudo-stigma; (*s*) opening of the pseudo-stigma communicating at (*si*) with the interior; (*o*) pseudo-stigmatic organ.

PLATE A.



A.D.Michael ad nat. del. W. Rhein sc.

Mintern Bros imp.

Anatomy of the exo-skeleton.

PLATE B.

EXO-SKELETON OF THE APPENDAGES.

Fig. 1. First leg of *Oribata piriformis*, seen from without. × 250. (1) The coxa; (1*a*) portion of same inserted into the body, and working in the basilar cavity; (2) the femur; (3) the gennal; (4) the tibia; (5) the tarsus and ungues.

2. Coxa of same leg; side view. × 250. (*a*) The tendon torn away from its attachment; (*b*) the same as (1 *a*), fig. 1.

3. Coxa of 1st leg of *Nothrus theleproctus*. × 170. Same lettering.

4. The same; side view; same amplification and lettering.

5. Coxa of 1st leg of *Tegeocranus coriaceus*. × 200. Same lettering.

6. Femur of 1st leg of *Oribata piriformis*. × 250. (*a*) Proximal end.

7. Femur of 1st leg of *Nothrus theleproctus*. × 170. (*a*) Blade.

8. Femur of 1st leg of *Tegeocranus coriaceus*. × 200.

9. Gennal of 1st leg of *Oribata piriformis*. × 250.

10. Gennal of 1st leg of *Nothrus theleproctus*. × 170.

11. Tibia of 1st leg of *Oribata piriformis*. × 250. (*a*) Tactile hair.

12. Tibia of 1st leg of *Nothrus theleproctus*. × 170. (*a*) Tactile hair.

13. Tarsus and ungues of 1st leg of *Oribata piriformis*. × 250.

14. The same of *Nothrus theleproctus*. × 170.

15. Coxa of 4th leg of *Oribata piriformis*, from without. × 250. (*a*) Blade; (*b*) portion inserted into the body.

16. The same of *Nothrus theleproctus*, from within. × 170. Same lettering.

17. The same of *Tegeocranus latus*. × 200. (*a*) Blade; (*b*) as in last two figures; (*c*) hole for insertion of the femur.

18. Femur and gennal of 4th leg of *Oribata piriformis*, from without. × 250. (*a*) Blade; (*b*) portion inserted within the coxa.

19. Femur of same leg from within; same amplification and lettering.

20. Femur of 4th leg of *Nothrus theleproctus*. × 170. Same lettering.

21. Gennal of 4th leg of *Oribata piriformis*. × 250. (*d*) Proximal end.

22. The same of *Nothrus theleproctus*. × 170. Same lettering.

23. Tibia of 4th leg of *Oribata piriformis*. × 250.

24. The same of *Nothrus theleproctus*. × 170.

25. Tarsus without ungues of *Oribata piriformis*. × 250 (*a*) Portion where the ungues are attached.

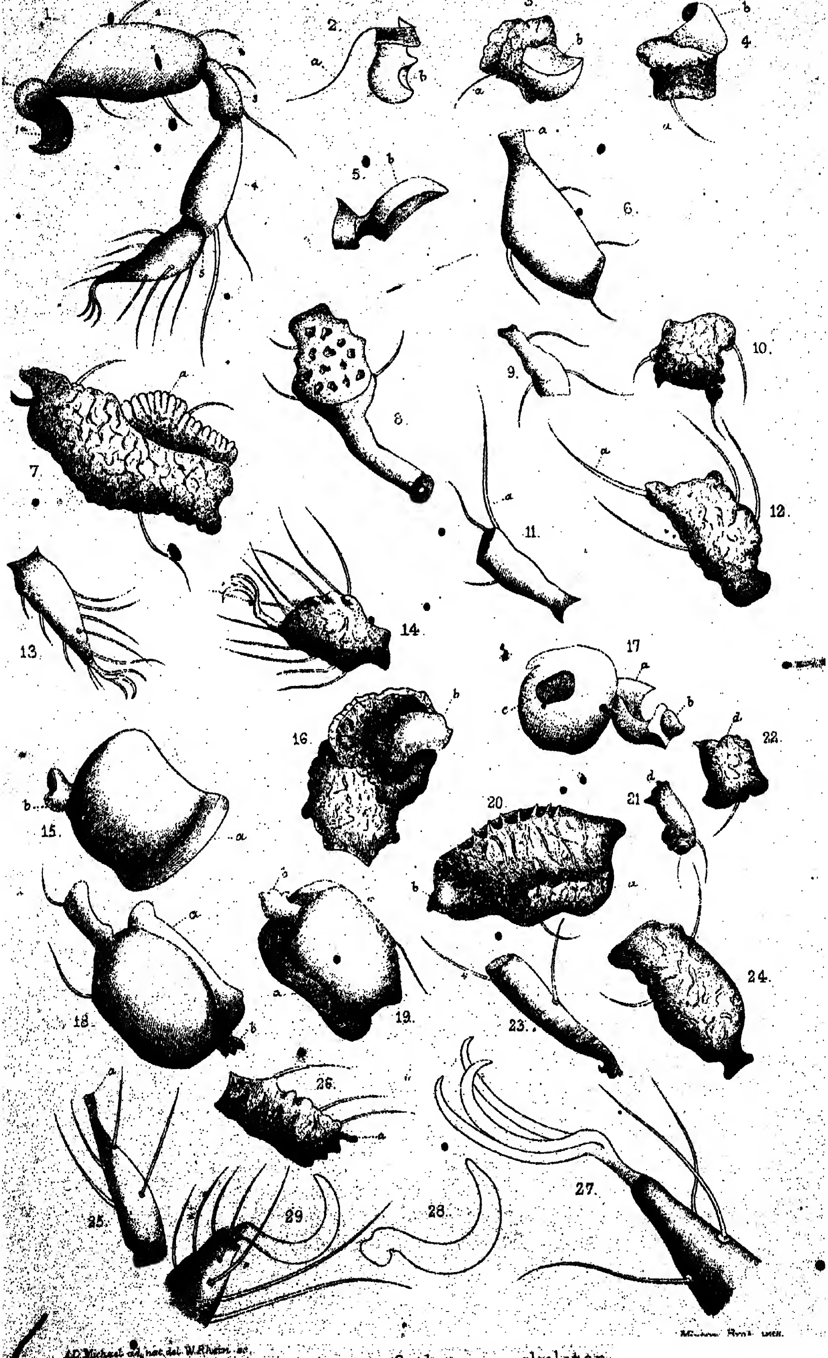
26. The same of *Nothrus theleproctus*. × 170. Same lettering.

27. Tridactyle claw of *Oribata piriformis*. × 700.

28. Central unguis of same detached. × 700.

29. Monodactyle claw of *Tegeocranus coriaceus*. × 700.

PLATE B.



Anatomy of the exo-skeleton.

PLATE C.

Exo-skeleton.

Fig. 1. Notogastral shield of *Oribata piriformis*. × 60. (*a*) Notogaster; (*b b*) pteromorphæ; (*c*) clear spot.

2. Notogastral shield of *Tegeocranus coriaceus*. × 80.

3. Left pteromorpha of *Oribata piriformis*, seen from above. × 125. (*a*) Portion of the notogaster; (*b*) pteromorpha.

4. The same, turned over to show the under surface; same amplification.

5. Left genital plate of *Oribata piriformis*, seen from below. × 250.

6. Left anal plate of *Oribata piriformis*, seen from below. × 250.

7. Right anal plate of same. × 250. Three-quarter view, to show curvature.

8. Genital plates of *Nothrus theleproctus*. × 200.

9. Anal plates of same. × 200. (*a*) end of fig. 10.

10. Chitinous piece situated in the abdomen, within the anal plates, having the end (*a*) turned towards those plates, and the curved part toward the genital plates. × 700.

11. A portion of the notogaster of *Oribata globula*. × 350.

12. A portion of the notogaster of *Cepheus tegeocranus*. × 350.

13. Diagrammatic view of half the cephalothorax of an *Oribata*. (1) The frons; (2) one of the genæ; (3) rostral hair; (4) pro-vertex; (5) dorso-vertex; (6) one of the lamellæ; (7) trans-lamella; (8) lamellar hair; (9) inter-lamellar hair; (10) first tectopedium; (11) pseudo-stigma; (12) pseudo-stigmatic organ.

14. Diagrammatic side view of the cephalothorax of an *Oribata*, same numbering, and (13) acropleuron; (14) basipleuron; (15) second tectopedium.

15. Longitudinal section through the cephalothorax of *Oribata piriformis*; same numbering, showing the trans-lamella cut across.

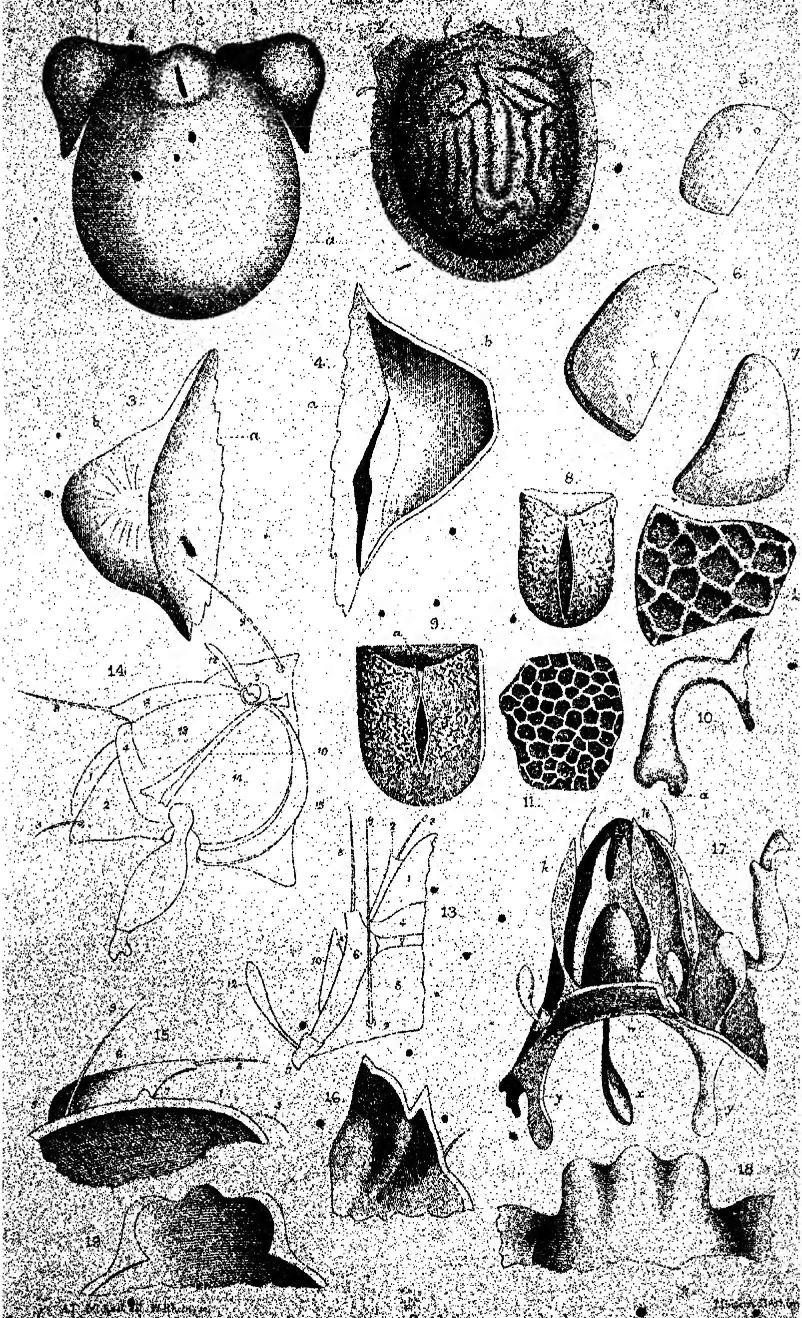
16. Longitudinal section through the cephalothorax of *Cepheus tegeocranus*, not quite central. The piece turned over and seen from inside, so as to show that the lamella is an out-folding of the cuticle. The lamellæ in *Cepheus* curve towards each other and almost meet, thus the section cuts across one lamella.

17. Cephalothorax of *Pelops acromios*. (*k k*) Inter-lamellar hairs; (*w*) phragma; (*x*) central and (*y*) lateral opistho-phragmatic processes.

18. Progaster of *Pelops acromios* from above.

19. The same, turned over and seen from within.

PLATE C.



Anatomy of the exo-skeleton.

PLATE D.

INTERNAL ANATOMY.

FIG. 1. *Nothrus theleproctus*, male; dorsal aspect. × about 60. The notogastral shield, the underlying fatty tissue, and the muscles, have been removed. The internal organs are shown protruding, as they usually do when the creature is opened, as though they were too large to be contained in the ventral plate. Part of the œsophagus is seen at the top (the brain having been removed); the preventricular glands (brown) lie on each side of the œsophagus. The ventriculus is coloured pink; part of it, and the whole of the cæca, are covered with botryoidal tissue (yellow). The testes (white shaded with blue) show at the sides, protruding below the alimentary canal.

2. *Hoplophora magna*; female; lateral aspect. × about 50. The chitin at the side, and the fatty tissue and muscles have been removed. The alimentary canal (ventriculus, colon, and rectum) are coloured pink; the cæca are strongly spotted. Preventricular glands brown; supercoxal gland (near to preventricular) white, with the vesicles yellow. Expulsory vesicle (between supercoxal and ovaries) white. Ovary and oviducts white shaded with blue. The rostrum (*a*) is shown raised; the legs extended; the genital plates (*gp*) and anal plates (*ap*) open; and the genital suckers (*gs*) extruded. The maxillæ are seen between the legs.

3. *Tegeocranus latus*; female; dorsal aspect. × 55. The notogastral shield, fatty tissue and muscles have been removed. The whole alimentary canal is shown. The brain (grey) lies above the œsophagus and between the preventricular glands. The supercoxal glands (grey) are outside the preventricular. The mandibles are seen from above and behind, their retractor muscles cut short. The tracheæ are seen proceeding to the acetabula of the legs. The great dorsal trachea to the third leg. The great ventral trachea is only seen where it emerges from below other organs. The lateral tracheæ are scarcely seen. None of the tracheæ would really be seen quite as far as the acetabula without dissecting, &c., as they dip down to reach the acetabula, and are hidden by other organs. This also applies to fig. 4.

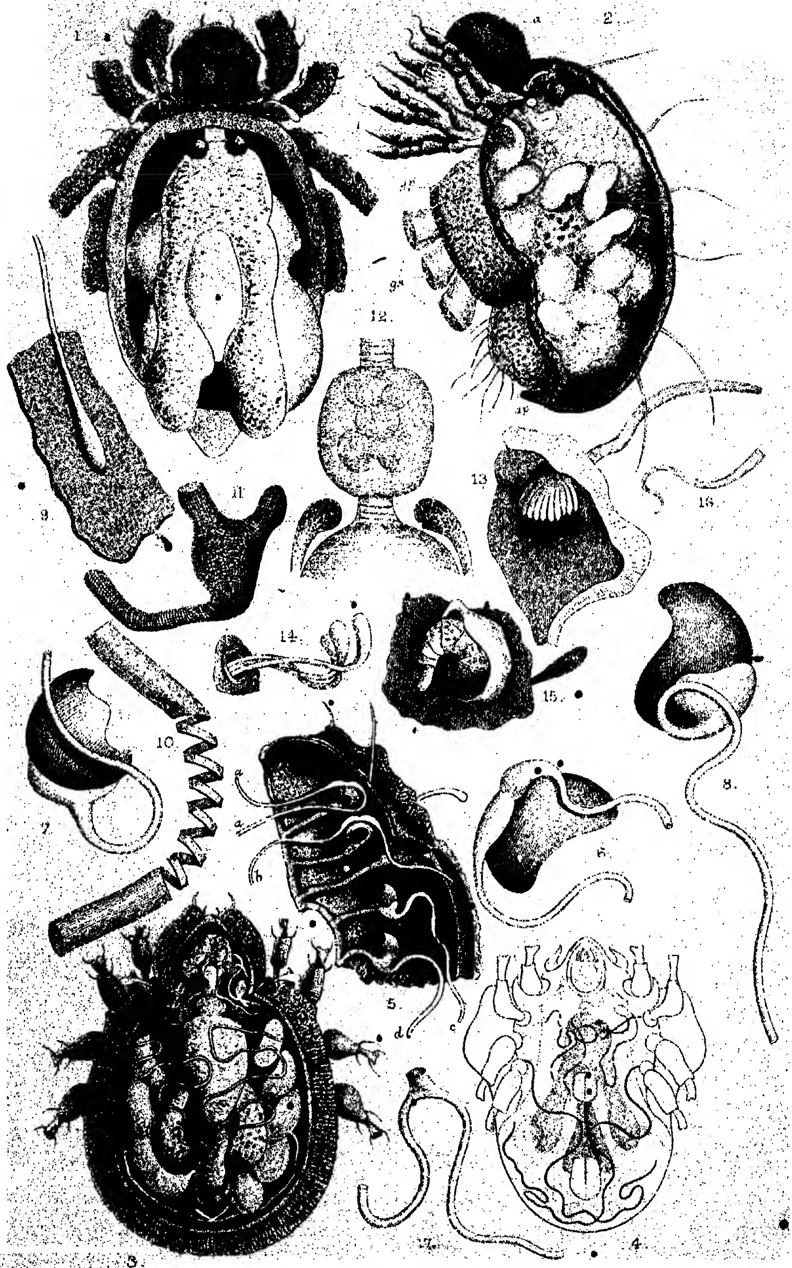
4. *Oribata lapidaria*. × about 45. Ventral aspect. Diagram to show the course of the tracheæ. The positions of the genital and anal plates and of the alimentary canal are indicated. The internal organs are supposed to be seen through the ventral plates (rendered transparent). Cephalothoracic and great dorsal tracheæ yellow; lateral tracheæ red; great ventral tracheæ black.

5. Right half of the chitinous parts of *Tegeocranus latus*. × about 110. The dorsal parts have been removed to show the apodemata, and the acetabula of the legs with the tracheæ proceeding from them. The tracheæ are washed out of posi-

tion to show them. (*a a*) cephalo-thoracic tracheæ; (*b*) lateral trachea; (*c*) great dorsal trachea; (*d*) great ventral trachea.

6. Acetabulum of the 1st (left) leg of *Damæus clavipes*, with double air-sac and tracheæ proceeding therefrom.
7. Acetabulum of the 3rd left leg of the same species, with single air-sac and trachea.
8. Acetabulum of the 3rd right leg of *Damæus geniculatus*, seen more from below than in fig. 7.
9. Bulbous ending of the great dorsal trachea of *Damæus geniculatus* immediately within the endostracum.
10. A portion of one of the larger tracheæ of *Damæus geniculatus*, after being subjected to pressure in glycerine jelly, showing the spiral structure revealed by this process.
11. Air-sac near the mouth of *Nothrus theleproctus*. × about 190.
12. *Nothrus theleproctus*. (*œ*) œsophagus; (*vt*) ventriculus; (*pv*) preventricular glands; (*br*) the brain, the light portion being the peri-encephalon.
13. The pseudo-stigma of *Nothrus palustris*, seen from inside the body, to show the bunch of small air-sacs springing from its interior. × 200.
14. The same part in *Hoplophora magna*. × 250. Showing the three small sacs.
15. The same part in *Nothrus theleproctus*. × 200. Showing the single cornucopia-shaped sac.
16. Interior portion of the pseudo-stigmatic organ of *Leiosoma* (*Cepheus*) *palmicinctum*, broken at both ends, showing the curved form, × 350.
17. Two tracheæ of *Damæus geniculatus*, uniting into a single trunk before their attachment to the acetabulum of the second leg.

PLATE D.



A.D. Michael ad nat. del. W. Rhein sc.

Internal anatomy.

PLATE E.

Alimentary Canal.

All the drawings are made from specimens stained with hæmatoxalin. (*œ*) Œsophagus; (*in*) ingluvies; (*vt*) ventriculus; (*si*) small intestine; (*co*) colon; (*cæ*) cæca; (*r*) rectum; (*pv*) pre-ventricular glands; (*ap*) anal plates; (*f*) labium; (*d*) maxillæ; (*e*) palpi.

Fig. 1. Alimentary canal of *Hermannia arrecta*; side view to show the natural position of the parts. × 60.

2. Alimentary canal of *Hoplophora magna*, extended, dorsal aspect. × 50

3. The same of *Nothrus theleproctus*. × 50.

4. The same of *Damœus geniculatus*. × 35.

5. The same of *Damœus clavipes*. × 50. Showing food-masses in most divisions of the canal.

6. The same of *Oribata punctata*. × 55.

7. Ventriculus, cæca, &c., of *Oribata punctata*, lately emerged, showing the different form of the cæca common at that period, and the distribution of the food in the ventriculus and cæca.

8. The same of *Leiosoma palmicinctum*, three-quarter view. × 50. Showing the pre-ventricular glands dissected away from the canal in order to show the ducts.

9. The same. Same species; larger specimen; front view. × 50.

10. A portion of the wall of the ingluvies of *Leiosoma palmicinctum* (seen from the outside), cut open and spread out, to show the transverse and longitudinal bands of muscle. × 120.

11. A portion of the wall of the ventriculus of *Notaspis bipilis* (from outside), young specimen. × 200. Showing the effect of the cellulation and thin layer of botryoidal tissue as seen from above.

12. Transverse section through the wall of the ventriculus of *Damæus geniculatus*. × 300. (*b*) Botryoidal tissue; (*tp*) tunica propria; (*g*) young Gregarines (Parasites) adhering to the walls of the ventriculus.

13. Longitudinal section through the thin portion of the small intestine of *Oribata punctata*. × 400.

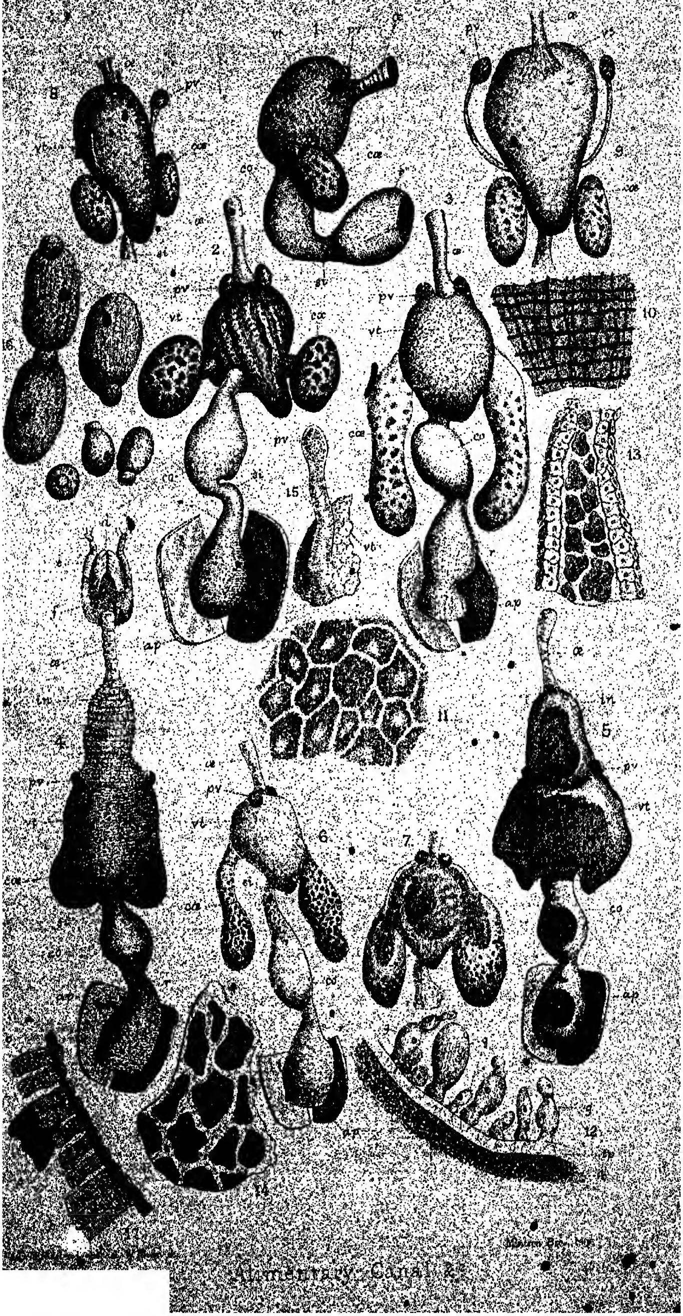
14. A portion of the distal end of one of the cæca of *Leiosoma simile*, laid open, and seen from within, to show the glandular structure. × 150.

15. Preventricular gland and duct of *Tegeocranus latus*. × 100.

16. Group of detached Gregarines (Parasites) from the interior of the ventriculus of one of the *Oribatidæ*. × 200.

17. The edge of the ventral plate of *Damæus geniculatus*. × 100. Showing the bands of muscle which attach it to the notogaster. (The bands are turned outward in the drawing to show them.) (*a*) Edge of ventral plate; (*b*) bands of muscle; (*c*) coxa of one of the legs.

PLATE E



Alimentary Canal.

PLATE F.

MALE REPRODUCTIVE SYSTEM; &c.

Figures 1 to 5 are from preparations stained with hæmatoxalin. (*te*) Lobes of the testis; (*vs*) flat portion of same, probably functioning as a vesicula seminalis; (*vd*) vasa deferentia; (*de*) ductus ejaculatorius; (*p*) penis; (*ps*) penial skeleton and sclerites; (*gp*) genital plates; (*t*) tendons for moving same; (*m*) muscles attached to these tendons; (*ap*) anal plates; (*gs*) genital suckers (so called).

Fig. 1. Male reproductive system of *Damæus geniculatus*. × 50. Seen from below, the lobes of the testes being turned outward to show the whole.

2. The same of *Pelops acromios*. × 35. Not showing the genital plates, &c.

3. The same of *Cepheus tegeocranus*, from above. × 50. (*a*) accessory sacks of large globular cells.

4. The same of *Nothrus theleproctus*, from below. × 40.

5. The same of *Oribata lapidaria*, from below. × 40.

6. Ductus ejaculatorius and penis of *Damæus geniculatus*. × 750. Side view.

7. The same; same species, from above. × 400.

8. Penial skeleton and sclerites of *Nothrus theleproctus*. × 600.

9. Penis of the same species, side view. × 1500.

10. Semen of *Damæus geniculatus*. × 1500.

11. One of the genital suckers of *Leiosoma simile*. × 350. (*cr*) Chitinous ring; (*a*) clear membranous collapsible portion; (*rm*) retractor muscles.

12. Super-coxal gland of *Leiosoma palmicinctum*. × 350. (*a*) Gland; (*b*) globular body (vesicle ?).

13. A portion of the left side of the same species; the dorsal shield and all the internal organs, except the super-coxal gland, having been removed. (*a*) wall of the rostrum; (*b*) 1st leg; (*c*) 2nd leg; (*sc*) supercoxal gland.

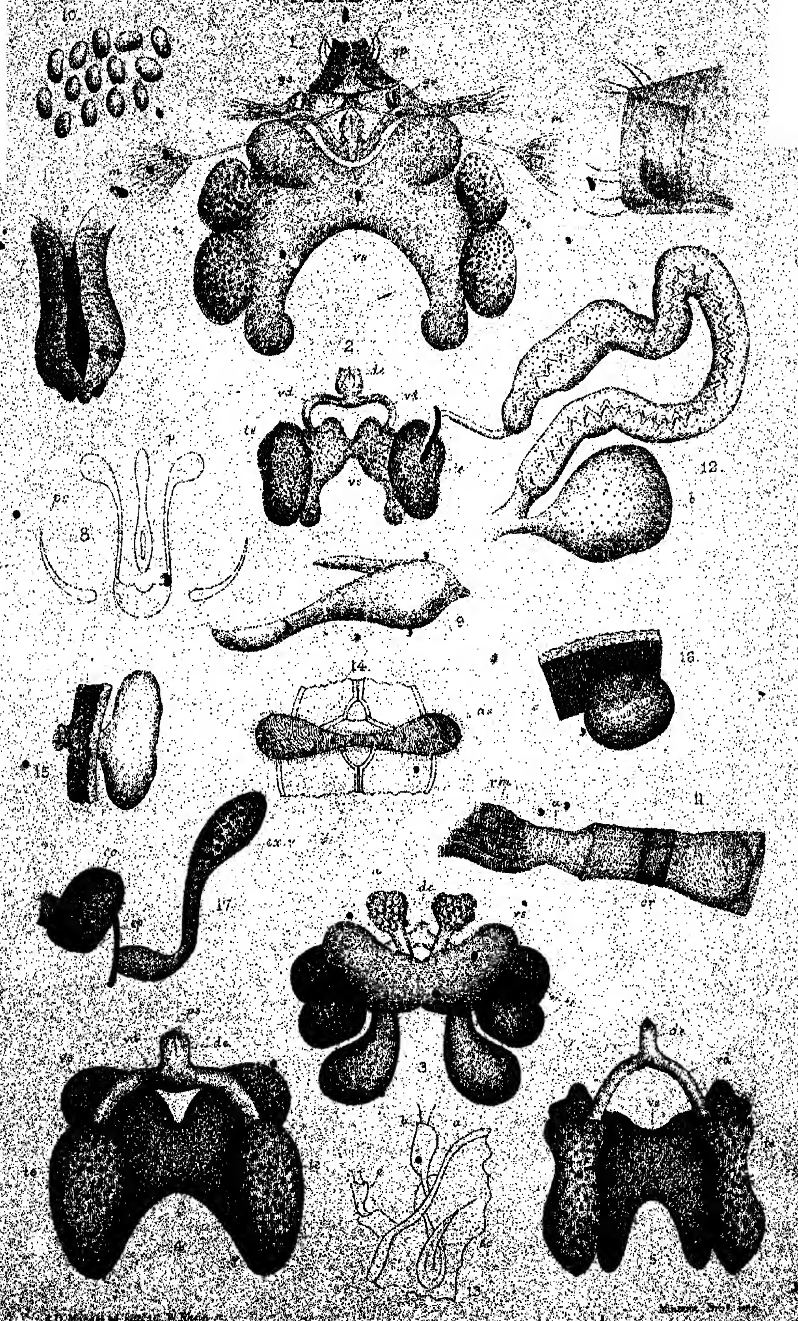
14. Anal sack of *Nothrus theleproctus*. × 100. (*as*) Sack.

15. Expulsory vesicle and lateral tubular chitinous projection of *Hermannia arrecta*. × 70.

16. Similar vesicle and foramen in the chitin of *Hermannia picea*. × 70.

17. Expulsory vesicle of *Hoplophora magna*. × 100. (*co*) Coxa of leg; (*ep*) epimeron; (*ex v*) expulsory vesicle.

PLATE F.



Male reproductive system, &c.

PLATE G.

Female Reproductive System.

(*ov*) Ovary; (*od*) oviducts (mostly containing ova, in various stages); (*od'*) portion of same between ovary and uterine chamber; (*ut*) globular expansion, or uterine chamber of oviduct (containing an ovum in course of development in fig. 1); (*va*) vagina; (*op*) ovipositor; (*c*) cusps of same; (*gp*) genital plates; (*gs*) the so-called genital suckers; (*t*) tendons for moving genital plates; (*m*) muscles attached by same tendons; (*ap*) anal plates.

Fig. 1. Female reproductive organs of *Damæus geniculatus.* Mature specimen with ovary nearly exhausted. × 50.

2. The same of *Cepheus tegeocranus.* Mature specimen, but ovary in full action. × 60.

3. The same of *Oribata lapidaria,* when the creature has just emerged from the nymphal state. × 40.

4. The same of *Oribata globula,* immature and still very small. × 55.

5. A portion of the ovary and oviduct of *Damæus geniculatus,* including the uterine chamber. × 120.

6. A small portion of the oviduct, containing an ovum of *Oribata punctata;* × 70; to show the character of the ovum of that species while still in the oviduct.

7. Genital plate and ovipositor, fully extended, of *Leiosoma palmicinctum.* × 100.

8. The same. Same species, to show the different forms which the ovipositor is capable of assuming.

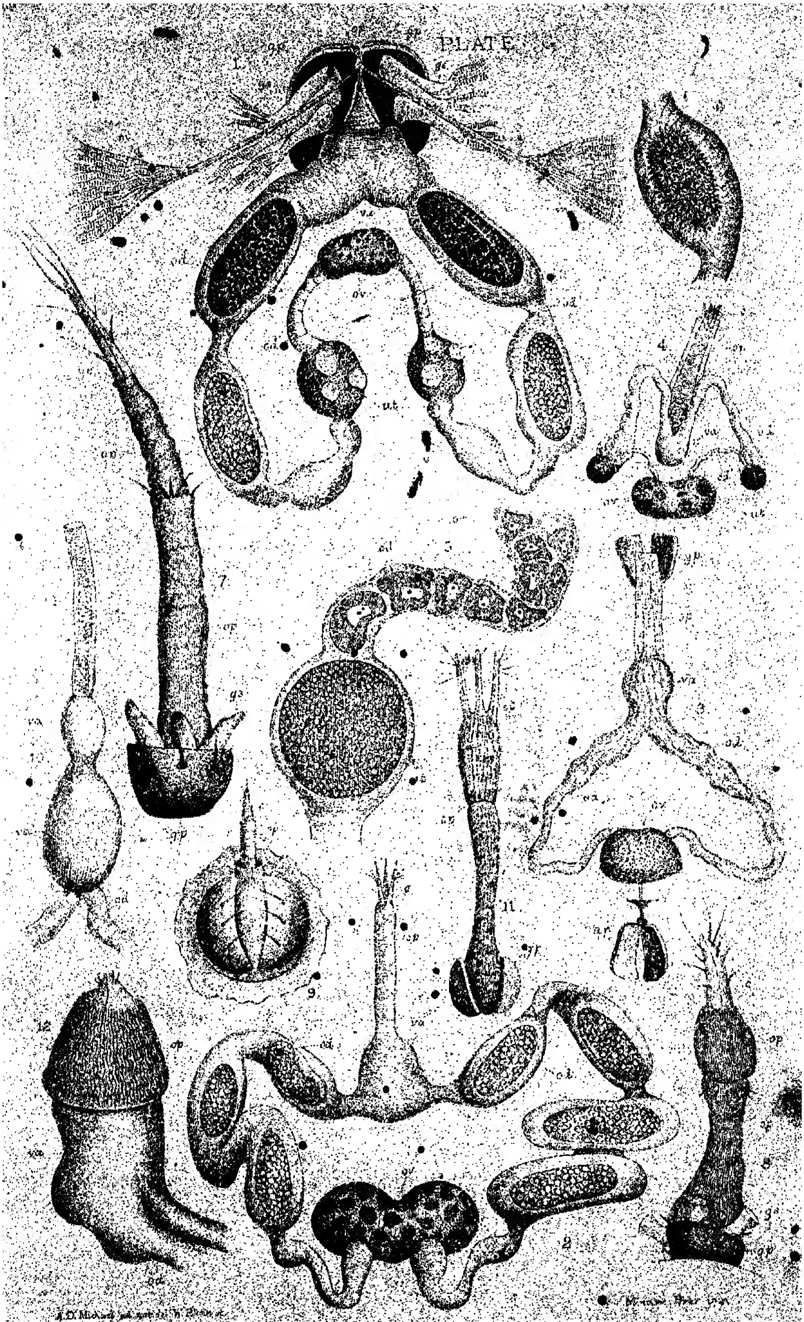
9. Genital plates and ovipositor, partly extended, of the same species. (*vp*) a portion of the ventral plate.

10. Ovipositor, &c., of *Oribata globula,* retracted.

11. Ovipositor of *Notaspis lucorum,* extended.

12. Vagina and ovipositor of *Damæus clavipes.* × 150.

PLATE



A.D. Michael del. West, Newman lith.

Female reproductive system. &c.